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Vol. IV October 1915 No. 7

EDITORIAL

A Lesson from Japan

A little over a generation ago the inconspicuous shogunate, as Japan then was, had nothing in common with the progressive modern Empire of the Mikado of today in scientific, material, economic, cultural, educational, and political advantages. Many causes, of course, contributed to bring about her present condition; but not among the least in importance was the effect of external influences.

The inauguration of the "open-door policy" marked a new era for Japan. The rapid influx of modern ideas from all over the world, as a result of the more liberal privileges extended to foreign missionaries, traders, and tourists, played no mean role in bringing her efforts at emancipation from centuries of backwardness to a successful end. And once she had realized the manifold advantages derived from this newly adopted procedure, Japan went a step further. She began to become dissatisfied with merely receiving what had been coming to her. The oath subscribed to by the Meiji emperor in 1868 had the following for its fifth article: "Knowledge shall be sought for throughout the world, so that the welfare of the empire may be promoted." Deserving Japanese young men were sent abroad at government expense and were given every opportunity to gather as much as they could from different institutions of learning, of the information that would add to their knowledge in their respective specialties. There was no country of importance that did not include Japanese members in the student bodies of its more prominent universities.

The wisdom of that course is, of course, evident from the results. A majority of the great statesmen of Japan, who have a prominent part in the enactment of her laws, determine the policies of her government and who are holding in their hands her national integrity, were men that for a part at

least molded their intellects from information secured abroad. Her present army compares favorably with any such organization in the world. The University of Tokio is run almost exclusively by foreign educated Japanese, who are not only well posted on their different lines but are also remarkable for their originality of thought.

Japan points with pride to her excellent agricultural experiment stations conducted by able Japanese experts. In many branches of science, indeed, Japan is not far behind the most advanced nation. The discovery of plague, diphtheria, and tetanus bacilli at once suggests the names of Kitasato and Aoyama; and other Japanese bacteriologists have done work of hardly less importance. Japan has her plant breeders, phytopathologists, mycologists, botanists, physiologists, zoologists and entomologists, whose brilliant accomplishments would be worthy of any nation's pride. We have enumerated only a few of the many instances of the product that Japan is now reaping from her farsightedness in the past. She has learned in time to prepare and save herself from the embarrassment of running a modern independent government with a lack of experienced hands.

Naturally the question occurs: May we not under the present circumstances profit by our neighbor's example? That our agriculture is up to this time in a pitiable state is a seemingly unbelievable truth when we consider that the Philippine Islands are by nature an agricultural country. Agriculture is our foremost industry, and it would be a shame were its present undeveloped condition to be allowed to continue. To develop it we need men,—not merely men who are willing to work, but men who are equipped with ample knowledge in the various lines of agricultural science, to enable them to direct this willingness along the proper paths. It is regrettable that even today, when we are considered far advanced in many different branches of learning, there is not a single Filipino whom we can point out as a real expert in any branch of agriculture. Tomorrow we may feel the need for them still more insistent; and such a class of people can not be made in a day, a month, or a year. They have to be provided for, many years in advance. It will not, therefore, be too early to prepare *right now.*

We firmly believe that the expenses needed to send agricultural graduates abroad to specialize along certain lines will be trifling compared with the sums voted by the government from time to time for matters of less importance. Furthermore, whatever may be spent in the former case will in due time be amply returned by the service such trained men will render towards promoting the advancement of our agriculture and thus establishing our country's prosperity on a firmer basis.—

L. B. U.

Study of Philippine Carabao

By Gaudencio Evaristo

Thesis presented for graduation from the College of Agriculture, No. 36.

In the Orient the Indian buffalo or the Philippine carabao is the most important domestic animal. This is because of the very varied services which it renders the peoples of these regions. The millions of Orientals, whose chief diet is rice, are largely dependent upon this useful animal in raising their supply of this cereal, for this is the only animal which the natives of the low and humid regions of India, China and the Philippines can use to cultivate the great rice-fields of those countries while covered with water—a system almost universally practiced. In the Agricultural Review of September, 1911 (Vol. IV, p. 487) it was pointed out that the carabao is the mainstay of agriculture, in that more than 90% of the draft work is performed by it. There are many other uses, enumerated under the discussion of the subject, that place the carabao far above all other domestic animals in the East, in importance.

Table I furnished by the Philippine Census of 1903 shows that there were 1,172,223 carabao in the Philippines on December 31, 1902. The following year, the loss from the attacks of diseases, principally of rinderpest, was 491,996, which is a little over 42% of the entire number. Table II taken from the animal statistics for the Philippine Islands, calendar year 1913, shows that but a very small number died of rinderpest, thus indicating the progress made toward the control of this disease.

TABLE I.

Data Obtained from the Philippine Census of 1903.

	No. in existence, 1902	*Death from disease*	*Slaughtered for food*	*Total No. left*
C. Bulls	278,331	138,334	17,018	122,979
C. Steers	311,892	109,483	12,591	189,818
C. Cows	428,523	176,312	17,448	234,763
C. Calves	153,477	67,867	7,882	93,311
Total	1,172,223	491,996	54,939	640,871

TABLE II.

Animal Statistics for the Philippine Islands
Calendar Year 1913.

Births	*Death from disease*	*Death from old age*	*Death from accident*	*Slaughtered for food*	*Total No. left*
121,968	7,636	3,917	5,583	17,890	1,047,160

TABLE III.

Extract from the Agricultural Review
Issued August, 1911.

Carabao actually living.	
1891	595,632
1903	640,871
1910	713,121

Table III shows a slight increase in number between the years mentioned. Aside from the common carabao diseases, there are other reasons for the slow increase of carabao in these Islands, chief among which are the improper breeding and selection and the lack of care. The available number of draft

animals here at present is so small in proportion to the increasing demand, that according to the report furnished by the AGRICULTURAL REVIEW issued September, 1911, the Philippines were importing annually 10,000 carabao from Indo-China.

There is every reason to believe that the demand for this useful animal will increase steadily, so that an early study of the animal with reference to its efficiency for draft purposes will certainly be beneficial. The 10,000 carabao imported annually from Indo-China can be raised here if better methods of breeding and selection are practiced and the death rate continues to diminish.

The average price for a good, mature but young animal is ₱125, though many sell for ₱135 up to ₱200. Calculating from this average price, if the 10,000 carabao could be raised here it would mean a saving of ₱1,250,000 annually for the Philippine Islands.

ORIGIN AND DISTRIBUTION

The domestic breeds which are now scattered throughout the East undoubtedly originated from the wild buffaloes of India. The date when domestication began and the period when the animals appeared in the various countries where they are now found are, however, usually unknown. It is said that they were introduced into Italy in the sixth century, and prior to this date were brought into Egypt. When the Spaniards came to these Islands, they found the carabao already here.

Small herds of wild buffaloes are still found in India, in the grassy jungles along the great rivers and in the open moist prairies—the finest occurring in Assam and Burma, and in the Straits Settlements, Java, Ceylon, Sumatra, Borneo and the Philippine Islands. To the westward, it has extended to southwestern Asia, Africa, along and far up the Nile and into the countries of southern Europe. Great numbers are kept on the bottom lands of the Danube, the Theiss, and the Drave in Austria-Hungary, and in Italy on the plains lying to the north and east of Naples. Buffaloes of the Jafarabide variety have also been introduced into Trinidad where they are used as draft animals, and are worked entirely by Hindu coolies. (Cycl. Amer. Agr., Vol. III, p. 292.)

GENERAL CONSIDERATIONS

"The buffalo is the largest of the Bovidae, measuring in the larger breeds up to six and one-half feet in height at the shoulders and ten feet in length from the muzzle to the base of the tail; body well rounded and large of girth; wither sharp and elevated; shoulders well formed; hind quarters less well developed; thighs thin; head comparatively small; muzzle large and carried well forward; limbs short and massive; horns large and much flattened or somewhat triangular towards the base, deeply ringed, directed backward or downward, finally curving upward or inward and becoming scimitar-shaped, usually very long, sometimes attaining the length of five or six feet; tail short, reaching to the hocks; skin a very dark bluish or grayish black, rarely brownish or dingy white, thinly covered with coarse black hair; hair on the forehead and knees more dense; young calves well covered all over." (Cyclopedia of American Agriculture, Vol. III, p. 292.)

The carabao is a semi-aquatic animal and thrives best in those parts of the country where water or marshes are abundant, a daily bath in a cool pool being necessary to keep it in good health during the hot weather.

It is a very powerful animal, good specimens measuring 64 inches at the

withers and having a chest girth of 94 to 96 inches and belly girth of 106 to 108 inches.

When newly born it is well covered with thick brown hair, but this becomes grayish or black as the beast grows older and gradually wears off till finally it is found only sparsely scattered on the body of the animal. The end of the tail is tufted. The inside of the ears is thickly covered with hair, but this wears off when the animal becomes old. In fact, the natives can tell when the beast is very old by looking at the ears, since these contain no hair at old age.

The horns are either long or short, curved upward or downward. Some have very big horns while others have slender ones. The horns are tapering in shape, big at the base, and gradually becoming sharp at the points. They are deeply ringed, and the rings indicate the age.

The ears are long, large and drooping. When listening attentively, they stand at right angles to the head. The eyes are either small, languid and deep set, or large, conspicuous, and bright, as in the case of active animals.

In most cases the body assumes the shape of a rectangle, the upper and lower lines almost running parallel to each other. In some cases the crop is higher than the withers and the abdomen lower than the chest. But in a good, strong carabao, the withers are well elevated, higher than the crop and heavily fleshed, and the chest is very deep, carried down much lower than the abdomen. The hoofs are similar to those of cattle, only very much larger. It is also similar to the vaca in having thirteen pairs of ribs.

The period of gestation is ten months (10 months and 10 days according to some), and the animal bears usually one, but very rarely two, young.

Some animals are very prolific, bearing young every year. Experienced farmers and herders say that carabao having long and big teats and exceptionally big belly belong to this group. It is said that one can breed them with any kind of male carabao and yet their prolificacy remains the same. Some females bear their young once every two years, others once every three years, while still others produce two young in three years. Some females, however, do not produce calves at all. The female carabao continues to bear till she is 20 to 25 years old. A carabao lives from 20 to 30 years.

Habits.—Carabao associate in herds, often of a large size. They graze in the morning and in the evening. In the middle of the day when the weather is hot, they wallow for hours in pools or streams with only their horns and faces above the water. When the water is not deep enough to cover their entire bodies, they dip their heads below the surface, then suddenly raise them, causing a stream of water to flow over their exposed backs. Where there is no water available, the carabao lie down under shade during the hotter part of the day.

They are very brave, especially the uncastrated bulls and the females with young. They are gentle with those whom they know very well, and greatly attached to them, but are inclined to be hostile to strangers. They are especially excited on the approach of a white man and often threaten to attack him viciously. If well cared for and sheltered, the carabao return, of their own accord, to their resting place when night comes, especially when fires are built around them every night.

Feeding and Management

The feeding of the carabao is a very important question, due to the fact that the vigor, the efficiency as a worker,

and the quality and quantity of milk that the animals produce, are practically dependent upon it.

The method generally practiced in the Philippines is to turn them loose over the fields after the harvesting period. Otherwise they are simply allowed to graze in neglected fields and along meadows, on the coarser grasses. If the feed they get from the fields is not enough, they are then given rice straw, or corn or cane forage, at night.

During the time of planting, the animals are almost invariably tied to stakes to depend for feed only upon such grass and leaves as may occur within a radius of about 20 to 30 feet. Usually they are put in places where water is accessible or shade is available so that they can either wallow or find shelter during the hotter part of the day. On account of careless herders, the carabao are often neglected, being allowed to remain in one spot during the entire day, thus feeding only upon a very limited area. Usually the animals are transferred at noon to other places where there is a better pasture. The above is the practice of the common farmer who owns but a small number of carabao. In the case of large herds and where pasture is available the animals are trusted to the care of one or more herders who lead them near to the foot of the mountains or on the sides of the hills, where there is more extensive pasture.

In Manila, where open pasture is very limited, there are better methods of feeding the animals. The feed consists of 15 to 20 lbs. of green grass, one chupa of rice cooked with plenty of water, and four to six centavos' worth of molasses mixed with the drinking water. There the animals are made to work continuously day after day, but yet remain healthy and vigorous.

A test for the amount of green forage eaten by the carabao and the amount of water it drinks in one day, both while at work and while at rest, are given below, petroleum cans being used for measuring the water drunk.

In all the feeding experiments, green corn forage and green grass were given. It will be noticed that the carabao eat and drink more when they are at work; but that less food is consumed when they are overworked, as when observations were made after letting the animals work during the whole week.

In Bukal, a town near Calamba, at certain times the carabao are fed entirely with sugar cane forage during the whole night after having worked during the day.

Notwithstanding all this varied and often improper feeding and adverse conditions of pasturage, on account of the active grazing habits of our carabao, they fatten very easily when allowed to roam freely.

It is evident that carabao can be improved, as draft cattle can, if more attention is given the matter of feeding. The feed given to cows will surely serve the carabao as well, and if better qualities of stock are required, it is but proper to raise different kinds of forage especially for these animals, to furnish them ample and better food.

Captain Channer (Tropical Agriculturist, 1882-3, p. 730) says that, in Ceylon, in addition to green forage, an allowance of 7 lbs. of concentrated food consisting of linseed, cotton seed and pulse-husks is given in three feeds daily to animals in full milk, the amount being lowered as the yield decreases. This probably improves the quality and quantity of the milk.

As in other buffalo countries, no special care is given to the management of the beasts in the Philippines. Enclosures where the animals are kept

TABLE IV.

GREEN FEEDS EATEN AND WATER DRUNK IN A DAY BY A CARABAO.

Number	Sex	Age	Weight	Green feeds eaten			Amount of water drunk		
				At rest	At work	after working the whole week	At rest	At work	after working the whole week
1.....	M	8 yrs.	1,224 lbs.	75.5 lbs.	82.0 lbs.	70.0 lbs.	3.5 cans	4.5 cans	4.5 cans
3.....	F	5 1/3 yrs.	1,120 lbs.	67.0 lbs.	72.0 lbs.	60.0 lbs.	3.0 cans	4.0 cans	4.0 cans
5.....	F	15 yrs.	1,015 lbs.	60.0 lbs.	65.0 lbs.	54.0 lbs.	3.0 cans	3.5 cans	3.5 cans
19.....	M	4 yrs.	1,402 lbs.	79.0 lbs.	85.0 lbs.	70.0 lbs.	4.0 cans	5.0 cans	5.0 cans
20.....	M	7 yrs.	1,603 lbs.	82.0 lbs.	90.0 lbs.	75.0 lbs.	4.0 cans	5.0 cans	5.0 cans

are built sometimes in the open and sometimes under the shelter of trees. No stabling is even thought of and rarely a roof of any kind. Oftentimes fires are built around the animals so as to prevent attacks of blood-sucking insects. When grazing where there are cultivated plants, buffaloes are usually guarded by boys who may frequently be seen sitting on the backs of the carabao while they are grazing, directing the animals by the nose strings, should they attempt to pass the boundaries.

Working animals are guided by a long rope tied to a ring in the nose and then passed around the horns to the hand of the driver. In some cases, when the animals are very docile, the rope is only tied to the base of the horns. Jerking the rope in a manner understood by the animal serves to guide its course. Carabao are usually driven single and are rarely yoked in pairs.

It is common to hear from the Filipino farmers that the efficiency of a working carabao depends upon its early training. At the age of 4 years (others begin even at the age of 2 years) the teaching begins, to prepare the beast to be a good working animal. It is made to carry light loads, usually a banana trunk; then the weight is increased, and the animal learns to pull. Two or three trunks are then tied together and the animal made to pull the load. This is continued for two or three weeks, this length of time depending upon the readiness with which the beast learns its task. The time for training should be during the cooler parts of the day. After this very limited training the carabao is ready for work.

If it is made to carry too heavy a load at the start, it is said that the animal gets tired very soon when it comes to actual farm work, so that our farmers think that great care should be taken in the early training of the carabao.

TYPES OR BREEDS

The principal aim of this work is to define the different types, as determined from measurements and examination of the external characters of numerous animals. The efficiency of these different types is determined by actual test while the animals are at work on the fields. There are other points of minor importance which are also taken up in this work.

Most of the investigation conducted in connection with this work has been carried on in Laguna and Zambales provinces. The investigation has also been extended to Rizal and the southern-most part of Pangasinan.

TYPES OR BREEDS IN INDIA

In India several breeds are recognized, but in some cases their characters do not appear to be defined very clearly while in others the recognition is purely local. Watt (Dictionary of Economic Products of India) recognizes the following five breeds:

1. Jafarabidi:—Is distinguished by the remarkably large frontal bones,

short, broad, much flattened horns, which are directed sharply backwards and downwards, then abruptly upward, so that the points are twined inward (horns in the males sometimes eight inches broad at the base); body very large and well set; temperament mild, cows noted for their great yield of milk.

2. Ramnard:—Horns of medium length, flattened, directed backwards, curving inward toward the tips; body low, thick-set and deep chested, hair brown or dun-colored; good milkers. This is an excellent variety, belonging to the Madras breed, and is found in the district lying to the southeast of Madura (Wallace).

3. Gujarat, Talabda or Goujal:—Much smaller than Jafarabidi buffaloes with comparatively short horns, milk limited in quantity but richer than in other breeds.

4. Nagpur:—Horns remarkably long, sweeping downward and backward and then upward; bodies low, massive and well set; hair black, males usually very large and used for hauling heavy loads; cows excellent milkers. This breed is very similar to the longhorned Bombay buffaloes and is probably identical with that breed.

5. Deccani:—Horns of medium length directed backward, downward and then upward, nearly in the form of a half circle; hair brown or chestnut. This breed is comparatively small and very hardy. The females are fairly good milkers. (Cyclopedia of Am. Agr., Vol. IV, p. 293.)

Condition of The Present Native Stock

The present carabao stock in the Philippines is in general inferior, small and lean and of a mongrel type. This undoubtedly results from a general lack of care and of effort in the selection of breeding animals. Due to the ignorance of the principles of selection, people never think of possibly controlling the character of the offspring their animals shall produce. Hence, a long period of indiscriminate inbreeding has been continued. According to the principles of breeding, the practice is destructive among poor stock since degeneracy takes place, if inbreeding is followed for an indefinite number of years. In this connection a practice that hinders the improvement of our native strain naturally arises from the uses to which the animals are put. As has been stated in the introduction, the carabao are the only domestic animals in great demand for draft purposes in the Orient. Therefore bulls showing the greatest development in size and strength are selected to answer the call. These animals are employed almost exclusively for cultivating rice-fields, for hauling timbers from the forest and for pulling heavy loads. To render them more docile and more easily managed, they are almost invariably castrated, for people say that uncastrated bulls are dangerous to handle. They are rough and wild and often threaten to attack even their own masters. This system, of course, results in the retention of the more poorly developed bulls for breeding purposes.

The slow increase of carabao here and the production of a poor type can be ascribed also to the fact that the natives, fearing the consequences that may arise by leaving the bulls uncastrated, castrate them when they are about ready to be trained for work, that is, when they are about three or four years old. This practice was found to be common in all places visited, where rarely, if ever, one can find one or two good bulls left uncastrated. They would only be able to breed just previous to their castration. It is a

common belief that bulls can be used for breeding purposes whether or not they are castrated. It is probable that in some cases the bulls are not wholly castrated, so that they are still able to breed.

The practice of giving the carabao a free run tends to produce good results in breeding. In the fields the bulls are pugnacious and the strongest animals are the masters, driving away the weaker ones. They then monopolize the females and hence the reproduction of the better animals takes place.

Types of Carabao in the Philippines

The present unimproved stock of carabao so far found in the Philippines is a mixture of different types. Cows and bulls are everywhere worked indiscriminately. No effort has ever been made to improve the stock, to separate the animals into types in breeding work. The present work has been devoted almost entirely to the study of types. There are three important factors taken as guides in classifying them, namely, their relative sizes, their external conformation, and their efficiency as working animals. The sizes are determined by their measurements and their efficiency as workers by observing them while they are actually at work on the fields.

So far, five distinct types have been distinguished. Many others may exist in these Islands. All should certainly be carefully and exhaustively studied to secure a more scientific breeding of this important animal.

Type I. (Plate I.)

This group can be easily distinguished from the others because of having the horns turned evenly backward, the curvature approaching a circle. The horns are decidedly long, so that, viewed from the front it will appear as though the whole body of the animal is inside the arch. The muzzle is large and remarkably square, indicating a superior grazing capacity. The nostrils are very wide, indicative of good respiratory organs. The forehead is large and the eyes are conspicuous and bright showing intelligence and alertness. The length of the face is within the average. The withers are well elevated, being much higher than the crop. The chest is very deep and carried well forward. As one stands in front he can readily see the great breadth of the chest. The ribs are well sprung, exceptionally wide, closely set and carried far downward. Throughout, the animal is heavily muscled. The tail is long, reaching a little beyond the hock, and its base is unusually large. Unlike the other types, the front legs are fairly straight. The arms are large and the cannon short. The hoofs are decidedly large and dense. The neck is short and massive. When in the field, if the day is rainy or cloudy this type can be seen pulling the plow steadily from morning till sunset, almost without rest. As shown in Table VI, the average area each carabao of this type can plow a day is 7,000 square meters in fairly light soil, and 5,000 square meters in heavy soil. Table V shows the dimensions of this type. Some students from Ilocos and Nueva Ecija say that animals belonging to this type can often finish one hectare of land a day during the rainy season. Even during the hot days, if the field contains enough water which can be used for wetting the animal, this type can endure plowing for the whole day, without resting. But in dry places, especially when the day is hot, in sugar cane or corn plantations, the animal

can work only from six to seven hours daily, the amount cultivated being 4,000 square meters on the average.

Type II. (See Plate II.)

This group can be termed the long-horned carabao. This is because they possess very long horns, curving only a little at the very end. The length of the horns runs from six to eight feet. This form has a poorer constitution than the first type. The muzzle is not so large, the eyes smaller but just as bright. The neck is not so well developed. The back is straight. The chest is carried higher than the abdomen. The ribs are not as large and not so well developed. The hoofs are not as large and not conspicuous. The animal is not as tall as the first. From the measurements in Table V, it will be seen how the animal compares with the other types in dimensions. This type of carabao is usually difficult to manage, being wild and easily heated. In endurance and strength, it is inferior to the first type. It can not stand continuous work, the limit being from 4 to 5 hours during the hot days, but can work the whole day during wet periods. The average land it can cultivate per day is about 5,000 square meters in rice-paddies, if the land is light, and about 4,000 square meters in heavy soil. In case of sugar or corn plantations, the average area it can plow a day is 3,000 to 3,060 square meters.

Type III. (See Plate III.)

This type of carabao has horns curving backward like a half moon. The central formation of the body is not constant. Sometimes it has a body similar to that of Type I in many respects; this is probably the result of crossing. In general, animals belonging to this type are smaller than either of the first two. They have, however, large barrel, indicating good capacity for digestion. Usually, in rice-paddies, they can also work the whole day but with occasional rests. On hotter days, they are only able to work from 4 to 5 hours daily. Some, however, can stand working as long as carabao of Type I. The amount of land it can cultivate a day in rice-paddies, in fairly light soil, is 3,000 square meters; in heavy soil, 2,000 to 2,100 square meters. The measurements in Table V show the dimensions of each carabao.

Type IV. (See Plate IV.)

This can be called the dwarf type, since they are very small. When plowing in sugar cane or corn plantations, as in the province of Laguna, where they are generally used for this purpose, each can finish on the average from 1,000 to 1,440 square meters a day. They are not commonly used in rice-paddies. Table V shows how small this animal is.

Type V.

Animals belonging to this type have their horns curved downward instead of upward. They have very poor muzzles, poor chest and barrel. Their eyes are small and languid, showing inactivity.

From this discussion and from the tables it will be seen that the carabao belonging to Type I are the best adapted to general farm work. In choosing a working carabao for general purposes, they should be selected. Prominent farmers from Zambales, namely, Don Antonio Venzon, Lorenzo Cabal, Matias Abastillas, Don Marcelo Marte, Don Gregorio Angeles and Francisco Lison, all give the same advise in regard to the selection of the best carabao for general farm work. Here follows a digest of their opinion: The body must be heavily fleshed; the withers must be higher than the crop; the chest wide and deep; the ribs large, closely

set, well sprung and must extend far downward; the arms big; the eyes bright, large and prominent, and the tail long, reaching beyond the hock, with the base large; when the animal walks, the foot prints must be in the same straight line and hind feet lifted about one hand beyond the marks made by the front feet. This type can be confidently recommended to the holders of the plow; if strong, intelligent carabao are wanted, those belonging to the first type should be chosen.

In Laguna province, where many of the carabao are imported from Indo-China, carabao of the first type are very rare. There are many of them scattered in Zambales, especially among the Ilocano towns. The Ilocanos of Zambales carry on the most extensive farming, and especial care is taken by them in selecting their work animals. One can hardly find a farmer in San Narciso, a town in Zambales inhabited by Ilocanos, using for plowing purposes a carabao other than this variety. In Ilocos Sur, Nueva Ecija and Pangasinan, this is also the type used, according to students from these provinces. In Sukat, a barrio in Rizal province, in a herd of about 50 carabao there were found but 4 that belong to the Type I.

At present there is no milking strain recognized in the Islands; but David G. Fairchild said that the best female carabao of the milch breed can be raised here if carabao of good producing capacity can be obtained for breeding purposes. He recommended that the best female carabao that can answer this purpose be brought from Delhi and Gujarat. The carabao from Delhi are called Surti. These produce each over 30 lbs. of milk a day and those of Gujarat produce about 20 lbs. daily.

Uses of the Carabao

There are a great many ways in which the carabao serves the people of the Far East.

In the Philippines, it is extensively used in preparing the rice-paddies. In this line of work the carabao has no equal and the vaca is of little use. This is because the carabao possesses remarkable strength and especially big hoofs, both characteristics being lacking in the case of the vaca. Strength is of vital importance because the rice-fields are muddy. Large hoofs are essential in order that the animal may not sink deeply into the soft muddy soil.

The area of land that can be plowed a day depends a great deal upon the efficiency of the individual animal, upon the nature of the soil, upon the climatic conditions, and, to a less degree, upon the man behind the plow.

Table VIII shows that the area of land plowed a day differs with the different types. The carabao of Type I can plow about 7,000 square meters a day when the soil is fairly light and about 5,000 square meters when the soil is heavy. This is when the day is either rainy or cloudy. In case of hot days, if not enough water is present in the field where the animal is working, delay is incurred in wetting the carabao and so the area that can be plowed will be smaller. When the driver is lazy the beast walks slowly, but under an active plowman, its gait is quite rapid. The other types are weaker, therefore a smaller area is cultivated. Some of the carabao belonging to Type III possess characteristics similar to those of the first type and in this case, they are as efficient workers as the first type.

There are peculiar characteristics possessed by the carabao that makes it unsatisfactory for the cultivation of the upland. It has thinly scattered hair, thick, tough skin and does not sweat freely even at hard work and on the warmest days of the year. This

makes it unable to stand the intense heat of the noon sun. Therefore in plowing sugar cane and corn plantations the carabao is not suitable. The vaca, however, can endure work where the heat is intense, and is therefore a better animal for the upland than the carabao. It is the opinion of many that, in the absence of mud, the vaca is in general better for draft purposes than the carabao. This is because the carabao moves slowly, is unable to resist the heat long, and can not perform heavy labor in the sun.

In Zambales, some of the Ilocano farmers, in order to utilize the great strength of the carabao, are accustomed to plow at night during the full moon. Students from Ilocos provinces say that the practice is common in their localities during the hot season. Where this can not be done, the carabao are only able to work four or five hours a day. The animals are employed very early in the morning, stopping at 8 or 9 o'clock. Then the work begins again at three to five o'clock.

In Bukal, a barrio near Calamba, a good method is employed to use the carabao to the greatest advantage. The animal is used for plowing beginning from 6 to 8 in the morning. The laborers, after taking their breakfast, commence to work again at 9 and continuous till eleven, using vacas because through the mid-day they have more resistance to heat. From one to three the vacas are again worked. Then from three to five the carabao are used. In this way, a larger area can be cultivated.

The carabao is able to plow a wider area in the lowland than in the upland. This is because the lowland, though muddy, is softer than the upland and the time for plowing is usually during the rainy season. Where there is irrigation, as is the case in Laguna province, preparation of the rice-paddies goes on even during the dry season. The farmers fill the field with water before plowing begins, so that they are able to wet the animal as many times as necessary and in this way it is able to work for the whole day.

In the preparation of sugar cane or corn plantations, the extent of the land that can be covered, when employing carabao of the first type, is about 4,000 square meters.

The carabao is also extensively used for hauling timbers from the forest and for carrying farms products. In these Islands we do not have good streams leading from the forest to the coast so that the demand for carabao is imperative. The weight of load which a carabao can pull varies. If the road is good as in Manila, and using the iron cart, a carabao can pull about a ton. (Table VIII.)

In the provinces where the roads are in bad condition and using the old fashioned cart, the strongest carabao can pull only 15 to 17 sacks of unhulled rice, having an approximate weight of two-fifths of a ton. Using the common sledge, the weight that can be pulled is much less.

The Filipinos use the milk of carabao practically to the exclusion of all other kinds. This is because they believe that is has a medicinal value, being able to cure consumption. It has a bluish tint, and to the European or American it has a slightly musky or insipid flavor. The milk of the carabao is richer than that of cows, as shown by Dr. Leather's analysis of carabao and cattle milk:

	Water	*Butterfat*	*Casein*	*Sugar*	*Mineral matter*
Cattle	86.66%	4.19%	3.13%	5.31%	0.71%
Carabao	82.14%	7.93%	4.09%	4.05%	.79%

At the present time no good milking strain can be found in these Islands.

By means of selection and better feeding, a great deal of improvement can be made towards the production of fairly good milk carabao. If the Delhi and Gujarat varieties are imported here, good milking strains can be quickly developed.

From our native milk carabao, 2 or 3 bottles of milk per day can be obtained (beer bottles being used for measuring) on the average.

Milking takes place once a day, usually in the morning, the hour not being fixed. Men of strong wrists are employed for milking. The carabao remains in milk from 9 to 10 months a year.

In many provinces, as Laguna, Pampanga, Bulacan, etc., the milk is used for making cheese.

Carabao meat is used only by the poorer classes of people, because of its poor quality and unpleasant taste.

In the olden time the number of carabao was greater than now, so that people had more than they needed for working. The carabao were then cheap and so people used them for beef purposes. Old people say that, formerly, a carabao at maturity cost only ₱5.00 and one newly born cost ₱2.00. Due to diseases, the numbers decreased. Agriculture is now advancing so that the demand for the carabao is greater than the supply. There are not any more available for beef purposes now. A law has been passed forbidding people to kill carabao that can be employed for draft purposes. Only animals incapacitated for work can be used for food. Table I shows that 54,939 carabao were killed for food in 1903 and Table II shows 17,890, this number being slaughtered in 1913. It can be seen that the number slaughtered has considerably decreased.

The hide of the carabao is comparatively light, durable and impervious to water. It is largely used here for making wooden shoes. Besides supplying the local demands, large quantities of it are also exported annually from Manila, usually to Chinese markets and sometimes to those of India.

The dung is occasionally used for fertilizer, either alone or in combination with ash.

Conclusion

1. The carabao which were studied can be divided readily into five distinct types, which differ widely in conformation and capacity for work.

2. Type I as described in this paper is of far greater value than the rest, and should therefore be chosen for breeding.

3. The early castration of the finest bulls is a fundamental mistake. They should be reserved for breeding.

Recommendations

1. Systematic breeding, looking toward the improvement of the Philippine carabao and the production of pure strains of fine type should be immediately undertaken in every province.

2. Studies of type and performance should be extended to every part of the Islands.

3. The carabao should be given better care and better feeding than it commonly gets.

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TABLE VI.

DETERMINING THE AREA OF LAND A CARABAO CAN PLOW A DAY.

Plowing Sugar-cane Plantation (San Narciso, Zambales).

No.	Sex	Age	Amount of Land plowed a day: Area in sq. meters	Depth in inches	Kinds of Soil	No. of hrs. plowing	Climate	No. of times wetted	Types
1	M	8	8,000	6	Fairly light	6	Hot and dry	Once at noon	I
2	"	8	7,000	"	"	"	"	"	"
3	F	5⅓	3,010	"	"	5	"	"	"
4	M	9	8,016	"	"	6	"	"	"
5	F	15	4,000	"	"	"	"	"	"
6	M	4	7,116	"	"	"	"	"	"
7	"	2	2,000	"	"	5	"	"	"
8	"	15	5,300	"	"	6	"	"	"
9	"	16	8,025	"	"	"	"	"	"
10	"	8	8,400	"	"	"	"	"	"
11	"	4	7,116	"	"	"	"	"	"
12	"	2	2,045	"	"	4	"	"	"
13	F	5	3,800	"	"	5	"	"	"
14	"	18	5,300	"	"	"	"	"	"
15	"	16	3,010	"	"	"	"	"	"
16	M	10	3,000	"	"	"	"	"	"
17	"	10	2,025	"	"	"	"	"	"
18	"	6	3,068	"	"	"	"	"	"
19	"	8	3,800	"	"	"	"	"	"
20	"	12	2,000	"	"	"	"	"	"
21	"	10	2,250	"	"	"	"	"	"
22	"	10	2,815	"	"	"	"	"	"
23	"	9	3,750	"	"	"	"	"	"
24	"	15	2,308	"	"	"	"	"	"
25	"	15	3,968	"	"	"	"	"	"
26	"	20	3,955	"	"	5	"	"	"
27	"	16	2,300	"	"	"	"	"	"
28	"	15	6,030	"	"	"	"	"	"
29	"	6	6,124	"	"	6	"	"	"

Plowing Rice-paddies (Cabuyao and Mamatid, Laguna).

No.	Sex	Age	Amount of Land plowed a day: Area in sq. meters	Depth in inches	Kinds of Soil	No. of hrs. plowing	Climate	No. of times wetted	Types
30	M	5	8,000	7	Fairly light	8	Little rain	None	I
31	"	6	8,400	"	"	"	"	"	"
32	"	8	7,045	"	"	"	"	"	"
33	"	5	7,116	"	"	"	"	"	"
34	"	5	8,016	"	"	"	"	"	"
35	F	10	6,025	"	"	6	"	"	"
36	"	18	4,500	"	"	"	"	"	"
37	M	6	6,560	"	"	8	"	"	"
38	"	14	6,700	"	"	"	"	"	"
39	"	16	6,780	"	"	"	"	"	"
40	"	5	6,030	"	"	"	"	"	"
41	F	6	6,025	"	"	6	"	"	"
42	M	4	7,340	"	"	8	"	"	"
43	"	8	8,035	"	"	"	"	"	"
44	"	10	8,909	"	"	"	"	"	"
45	"	20	4,831	5	Heavy	11	Hot	Several times	"
46	"	15	4,800	"	"	"	"	"	"
47	"	17	4,600	"	"	"	"	"	"
48	"	9	6,509	"	"	"	"	"	"
49	"	10	6,315	"	"	"	"	"	"
50	F	6	6,294	"	"	"	"	"	"
51	"	7	6,040	6	Fairly light	"	"	"	II
52	"	12	4,025	"	Heavy	"	"	"	"
53	M	14	4,116	"	"	"	"	"	"

Measurements of Some Philippine Carabao.

(All measurements in inches.)

The first one hundred belong to Type I. Those not specified belong to Type III.

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
Length between the eyes	11	11	11	5	10	5	11	5	12	0	11	10.5	11.0	11.5	10.8	11.0	11.0	11.0	11.0	11.0	11.0	11.5	10.0	11.0	10.5	10.0	11.0	11.0	11.0	10.5	10.8	11.3	11.2	10.5	10.0	10.0	10.8	10	6	10	5	11	4	11	0
Length of the head	22	22	20	20	23	22	21	25	21	21	21	21	21	22	21	21	23	20	21	21	21	20.5	21	21	21	21	21	21	21	21	21	21	20	20	20	5
Length of the back	37	33	33	29	36	35	29	34	31	32	36	35	32	29	28	33	37	28	34	32	28	33	37	35	33	29	31	37	36	33	36	37	34	32	35	35
Length of the crop	14	14	14	13.5	13	14.5	14	14	12	14	12	14	12	14	12	14	14	12	14	12	12	12	14	14	14	12	13	13	15	14	14	12	14	13	14	12
Length of the body	66	66	61.5	63	63	64	62	67	60	58	60	60	60	58	60	62	68	60	62	65	60	59	66	58	60	60	62	60	58	58	66	63	65	60	62	56
Length between haunch and pin bone	20	20	19	19	19	21	19	21	18	18	18	19	20	19	20	21	22	18	20	21	19	19.5	20	18	19	18	18	20	18	18	18	19	20	20	18	20
Length of the cannon	9	10	9.5	10	10	10	9	11	9	10	10	9	9	9	9.5	9.8	10	9	9.4	9.5	9	9.5	9.5	10	10.2	9.6	9.2	9	10	9.5	9.8	9.6	9.4	9.5	9.4	10
Circumference of forearm	24	24.5	22.5	21.5	24	24	23	26	23	23	24	25	24	23	22	24	27	21	22	21	23	26	24	26	26	23	24	26	23	22	24	26	23	26	24	23.6
Circumference of gaskin	27	26	26	25	27	28	25	27	26	25	26	27	26	25	26	27	28	23	25	25	25	23	25	27	27	25	26	28	25	27	25	28	25	28	26	25
Circumference of heart-girth	90	90	89	90	88	92	88	94	94	88	89	92	94	88	94	92	96	86	90	88	92	94	90	88	90	89	90	96	94	94	94	90	90	92	92	96
Circumference of abdomen	105	105	102	102	104	106	102	106	104	98	100	106	108	105	104	106	108	98	103	100	108	106	105	102	106	104	108	100	104	104	108	100	100	104	104	105
Breadth at the shoulder	21	20.5	19.5	20	21	21	20.5	20.5	18	18	19	21	21.8	20	20	21	22.5	20	19	18	19	21	20	21	22	20	20	22	21	20	21.5	18	19	21	22	19
Breadth at the chest	24.5	26	23.5	25	24	25	23	22	22	22	24	24	26	22	26	22.5	26.5	22	22	26	22	26	24	26	26	23	24	26	23	22	24	26	23	22	24	24
Breadth at the haunch	25.5	25.5	24	24	23	25	23	26	24	24	23	26	26	25	25	23.5	27	24	25	25	25	23	26	25	26	27	26	26	27	25	26	24	23	25	25	23
Breadth at the hips	23.5	22	21	23	21	22	21	23	22	21	21	24	24	23	22	20	25	20	23	25	23	23	20	20	23	24	24	24	25	24	22	23	22	23	22	24
Depth at the chest	34	34	33.5	34	35	36	34	36	33	32	34	36	34	36	32	31	36	30	34	32	34	32	34	34	32	32	34	36	34	34	34	35	35	35	36	34
Height at the withers	60	60	59	58	59	60	58	58	52	52	56	60	58	60	62	56	62	54	58	60	60	62	60	58	60	60	62	60	60	62	64	59	62	63	61	60
Height at the crop	58	59	55	56	56	57	57	55	51	50	54	59	57	59	60	55	61	51	56	59	58	60	59	58	58	58	59	58	59	61	63	59	62	63	60	58

	Type I.																	Type II.																		
	37	38	39	40	41	42	43	44	45	46	47	48	49	50	98	99	100	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
Length between the eyes	11.5	10.8	10.5	10.0	10.0	10.5	11.0	11.0	10.5	10.5	11.0	11.0	11.0	11.5	11.0	11.5	11.5	10	10	9.5	9.6	9.8	10	9	9.2	9.3	9	9.2	9.2	9.3	9.5	9.5	9	9.2	9.2	9.3
Length of the head	20.5	20.5	21	21	21	20.5	20	20.5	21.5	21	20	20	19.8	18	21	21	25	22	22	24	22	25	20	20	20.6	20.5	21	21	21	20	20	20	21	20	20.5
Length of the back	37	29	35	28	36	35.5	33.8	34.6	34.9	36	35.5	30	28	28.1	29	35	29	28	29	30	30	31	30	32	31	30	26	26	28	29	28	30	31	26	26	
Length of the crop	11.8	11.8	13	13	13	14	14	14.0	13	15.8	13	14	13	14	13	12	15	12	12	13	12	12	13	10	11.5	11	11	11.6	10.8	11.5	10.6	10.2	11	11	11.3	11.5
Length of the body	58	59	62	66	65	66	62	61	60	67	60	58	62	67	66	58	67	58	54	56	54	56	56	50	53	53	50	52	54	50	52	53	52	56	57	52
Length between haunch and pin bone	19	18	20	21	20	21	18	18	18	19	19	18	20	21	20	20	21	19	20	19	20	20	20	17	17	16	17	17	17	16.5	16.5	17	17	17.2	17.3	17.6
Length of the cannon	10.2	10.1	9.2	9	9.3	9.5	9.5	10	10	10.2	10	9.4	9.6	9.5	10	9	10	11	11.5	11.6	11.8	11	10.9	10	10	10	11	10.6	10.5	10.3	10.5	11	11	11.2	9.6	9.4
Circumference of forearm	24.5	25.1	25	26	22.4	24.5	25	26	25	26	21	22.5	20	22	24	25	23	26	22	21	22	21	19	17	17	18	20	20	18	20	18	18	18.4	18.6	20	
Circumference of gaskin	26.5	27.3	26	28.5	25.5	26.3	28.4	27	28	24.3	25.2	23.8	26.5	27	28	26	28	24	23	23	24	23	22	21	20	21	21	22	20	22	21	20	23	20	24	23
Circumference of heart-girth	94	96	96	94	93	92	93	94	96	90	90	93	92	93	94	96	94	88	86	84	84	86	88	87	86	82	76	78	78	76	80	82	82	78	78	80
Circumference of abdomen	104	108	108	100	103	102	100	104	108	100	100	104	102	104	102	106	108	98	100	96	96	98	100	90	92	90	88	88	86	86	88	88	90	90	88	
Breadth at the shoulder	18	21	21	21	18	18	22	20	21	20	20	21	22	21	21.5	20	22	17	17	18	17.8	18.1	18.4	15	16	15	15	14	16	14	14	16	17	17.5	17	16
Breadth at the chest	22	23	24	23	22	20	24	22	25	23	25	24	24	23	23	22	24	19	18	20	20	20	20	18	18	19	18	18	18	19	19.5	19.6	19.2	19	18	18
Breadth at the haunch	24	26	27	25	23	22	27	20	26	25	27	26	26	25	25	24	26	23	23	22	21	22	24	24	22	20	20	21	20	21	20	20	21	20	22	21
Breadth at the hips	20	23	25	22	20	20	24	20	23	22	23	24	23	23	22	21	24	19	18	18	19	18.6	18.5	18	17	18	18	17	19	18	19	20	19	18	17.5	
Depth at the chest	35	36	34	31	31	31	35	31	35	34	34	34	34	32	31	29	29	30	32	32	31	31	31	28	30	32	30	28	28	27	30	28	28	27	30	30
Height at the withers	58	58	59	62	60	60	62	64	58	59	59	60	58	58	56	56	52	56	54	56	52	56	51	52	52	51	60	60	52	62	51	52	52	60	62	
Height at the crop	58	58	57	60	58	58	60	54	56	58	58	59	60	56	56	54	55	53	56	55	56	52	57	51	52	52	51.5	60.4	60	52	62	51	52	52	60	62

	Type II.																							Type I.												
	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96	97	51	52	53	101	102	103	104	105	106		
Length between the eyes	10	10	9.8	10	9	9.8	10	9.5	10	10	9	10	9	9	9.5	9	10.2	10.5	10	9	9.2	10	9.6	9	9	10.5	10	10	11.5	11	9	9.5	9.2		
Length of the head	20.6	20.4	21	20	21	20.5	20.5	20.5	21	21	20.5	21	20.2	21	20	21	20.5	20.5	20	20	20	20.5	21	20.5	20	22	22.5	22.6	19	21	20	20	21	20	
Length of the back	32	30	31	26	24	26	29	30	30	32	32	33	33	31	30	34	28	30	29	30	30	34	32	29	34	36	37	37	35	34	30	32	34	31		
Length of the crop	11.6	10.8	10.9	10.4	10.6	11.2	11	11	10	10.5	11	11	11	11	10	11	10	11	11	12	12	10	10	12	13	13	13	14	15	11	11	11	10			
Length of the body	50	51	52	53	54	52	52	50	53	57	55	55	58	59	53	59	55	54	56	54	52	52	53	52	54	62	64	64	60	64	54	56	53	53		
Length between haunch and pin bone	16.8	16.8	16.8	17	18	18	18	18	17	19	18	18	18	20	18	21	17	17	18	18	18	18	17	17	19	20	20	22	20	21	17	19	18	18		
Length of the cannon	9.8	9.6	10	10	10	10.2	10.3	10.4	10	10	10	10	10	9	9	10	9	9	11	11	10	10	9.5	9	11	11	10.5	11.2	9	9.5	10	10	9.5	10		
Circumference of forearm	19	20	19.2	19.8	19.6	19.2	20	20.2	20	20	21	22	20	18	19	21	18	17	21	18	17	18	17	17	19	22	22	21	23	26	18	20	19	18		
Circumference of gaskin	22	22	20.5	21	21.5	21.6	22	22.3	22	22	23	22	23	22	18	23	24	28	25	18	20	20	18	20	24	24	23	24	25	28	22	23	22	22		
Circumference of heart-girth	76	72	84	88	76	72	72	74	78	82	79	70	84	78	76	86	78	84	88	78	74	75	78	79	82	86	84	84	90	94	80	78	76	84		
Circumference of abdomen	92	98	88	89	88	89	90	92	97	96	92	96	98	90	82	96	78	92	94	96	92	90	92	92	96	100	102	102	100	104	96	92	88	92		
Breadth at the shoulder	17	18	16	16	15	15	18	15	16	17	16	16.5	17	17	17	17	18	16.5	17.5	16	16	17	16	17	18	18	17	17	21	22	16.5	18	18	17		
Breadth at the chest	19	19.6	18.4	19	18.2	18.6	18.4	18.2	18.5	20.5	19	18	20.5	23	19	20	20	18	20.5	18	19	19	18.5	20	22	19	18	18	24	25	21	22	21.5	20		
Breadth at the haunch	24	23	20	21	22	20	23	23	21	24.5	24	23.5	20.5	22	22	23	23	22.5	24	23	22.5	23	23	22.5	24	20	22	22	25	27	21	22	22	21		
Breadth at the hips	17.6	18	18.4	17.6	17.5	18	18	18	18.5	20.5	19.5	21	19	20	20	22	19	19	20	19	18.5	20	20	20	22	18	18	18	22	23	17.2	18.5	18.3	20		
Depth at the chest	13.5	32	31	32	28	27	28.6	28.2	35	36	31	31	31	32	28	34	30	31	35	31	34	34	32	28	36	30	31	31	34	36	28	29	30	31		
Height at the withers	64	58	51	51	52	51	51	52	52	52.5	53	54.5	54	55	51	56	50	51	53.5	53	53.6	52.3	55	52.9	56	57	57	56	58	59	53	55	54.2	51.3	
Height at the crop	64.6	58	51	52	52.5	51.6	52	52	51	53	52	54	53	54.5	51	56	50	51	53.5	53	53.6	52.3	55	52.9	56	57	57	56	58	59	53	55	54.2	51.3	

	Type I.																															Type II.				
	107	108	109	110	111	112	113	114	115	116	117	118	119	120	121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140		
Length between the eyes	9	9.5	10	10	9.6	9	9.4	9.4	9.6	9	9	10	10	9.4	9.4	10	11	10.6	10	9.8	11	9.6	9.8	10	9.8	10.5	11	12.2	11	11.2	10.8	10.6	9.5	10		
Length of the head	20	21	21	21	20.2	21	21	21	21.4	21.6	21.8	21	21	20	20	20	21	20.5	20.3	20	21	20	21	21	21	20	21	21	21	21	21.4	22	22.5		
Length of the back	31	31	30	30	34	33	33	34	28	30	29	31	31	34	31	30	30	28	28	28	35	30	32	31	30	35	36	36	30	32	32	30	29	28		
Length of the crop	11	11	12	10	10.5	11	11.2	10.8	10	10	11	11.5	10.5	10.8	11	11	10	11	10	10	12	13	11	10.2	10	14	14	14	12	13	13	11	12	12		
Length of the body	54	50	50	52	52	54	58	52	52	50	50	50	48	49	48	50	48	53	52	50	59	48	48	50	60	58	58	58	58	59	58	56	56			
Length between haunch and pin bone	18	16	17	17	16	16.3	16.5	18	17	18	18	18	17.2	18	17.5	16	16	16.2	16.3	16.5	20.3	16.5	18	18	18	18	20	21	18	18	19	18	20	20		
Length of the cannon	10	10	9	9	11	10	10	9.2	9.5	10	10	10	9.6	11	9.3	9.8	10	9.2	9.4	9.4	9.5	9.6	9.8	10	10	9.6	9.8	9.5	10	9.6	9.4	9.8	12	11.8		
Circumference of forearm	20	20	19	19	20	20	20.5	22	21	22	19	22	23	20	18	18	17	17	18	18	22	19	18	17	17	26	24	25	20	19	20	21	19	19		
Circumference of gaskin	23.5	20	21	23	21	22	22	24	26	24	23	24	24	21	20	20	21	20.5	21.6	21.2	23	22	20.9	21	20.6	27	26	26	26	28	25	26	22	24		
Circumference of heart-girth	84	70	80	78	78	82	84	71	73	73	75	80	80	78	82	86	82	84	76	78	76	79	82	82	80	90	93	93	86	88	90	90	84	84		
Circumference of abdomen	94	90	92	88	89	94	96	84	90	88	88	96	92	89	92	94	96	92	84	88	86	88	90	90	94	100	102	102	94	98	100	100	94	96		
Breadth at the shoulder	18.5	16	16	16	18	18	16	17	17	17.8	16.9	17.2	18	16	17	17	18	17.3	18	18	19	18	18	16	17	21	22	22	18	20	20	21	17	17		
Breadth at the chest	23	20	18	20	18	20	20	19	19	18	18	20	21	20	21	18	19	20	22	20	22	20	22	18	19	24	25	24	23	24	24	23	20	19		
Breadth at the haunch	23	24	21	22	20	23	22	21	23	24	23	22	23	21	22.5	20.8	20.8	20	22	20	23	21	22	20	21.3	26	27	26	24	26	26	25	23	21		
Breadth at the hips	20	20	20	20	18	20	19	18	19	20	18	19	19	18	20	18	18	18	20	19	19	19	18	18	18	24	23	23	22	24	25	23	19	20		
Depth at the chest	29	32	30	31	31	34	36	34	30	32	30	30	34	32	30	32	32	32	30	36	34	36	34	30	32	34	32	31	34	34	32	30	30			
Height at the withers	54	56	53	53	53	54	54	53	54	52	52	56	54	52	54	54	52	54	50	51	50	52	50	50	51	55	58	58	57	58	58	58	54	53		
Height at the crop	54	56	54	53.5	53	54	55	53	54	52	53	56.5	54	52	54	54	53	53	50	51	50	52	51	50	51	56	56	57	57	56	57	54.4	54.1			

	Type I																																Type II			
	141	142	143	144	145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168	169	170	171	172	173			
Length between the eyes	9	9	9.2	9	9.3	9	10	11	10	9.5	9.2	9.6	9	9.4	9.5	9	9.8	9.3	9.4	10	10	9.6	9.2	10	9.8	12	11.8	10.5	11.6	9.5	10	9.2	9			
Length of the head	20	20	21	21	21	21	22	20	21	20	21	20	20.5	21	20.5	20.5	21	21	20	20	21	21	21	21	22	21	21	21.3	22	22.3	22.5	20.8				
Length of the back	30	28	28	28	29	30	30	28	28	30	30	31	30	31	29	31.6	31.2	30	30.2	31	29	28	28	30	32	37	34	34	36	32	32	33	29			
Length of the crop	10	10	10.9	10.8	11	11	10.6	10.8	10.5	10.5	11	10	10	11	12	11	11	10.9	10.8	11	11	13	12	12	12	15	14	14	12	12	12	12	11			
Length of the body	50	52	60	52	54	56	55	50	50	48	48	50	52	50	54	54	53	54	50	49	48	58	56	56	52	67	60	60	58	56	58	58	56			
Length between haunch and pin bone	16	16	16.8	16.8	16.5	17	18	18	17	17	16.9	16.5	17	17	18	17	18	17	18	18	18	18	16	16	17	21	20	20	19	19	19	18	16			
Length of the cannon	10	10.2	10.3	10.5	11	10.6	10.8	9.3	9.8	10.8	10.2	10	11	11	10	11.2	11	10	9.6	9.6	9.2	9.5	10	9.8	9.8	9.4	9.5	9	10.8	11.2	11.4	10				
Circumference of forearm	18	20	22	19	18	18	18	20	20	21	21	19	18	19	19	20	21	19	21	21	20	20	18	20	22	26	22	24	22	21	20	21	20			
Circumference of gaskin	20	20	23	21	20	22	22	21	20	23	24	20	21	21	20	21.6	21.6	21.6	22	21	22	22	20	21	20	22	23	28	24	26	24	23	22	22	22	
Circumference of heart-girth	76	78	78	80	84	80	80	79	78	79	78	80	88	84	86	90	82	78	74	74	78	88	90	84	80	97	92	94	90	86	88	88	76			
Circumference of abdomen	90	88	85	92	92	89	88	87	88	86	84	90	91	92	90	94	89	86	88	88	88	96	100	94	96	108	102	102	100	100	98	92	88			
Breadth at the shoulder	16	16	16	17	16.3	16.8	16.7	15	18	17	15	17	18	18	16.9	18	17	17	16	16.8	16	16	18	20	20	18	20	21	21	18	17.6	18.5	20			
Breadth at the chest	20	20	21	19	18	18	19	20	20	19	18	19	20	19	18	20	20	20	21	20	20	19	21	21	20	25	22	23	23	19	20	20	21			
Breadth at the haunch	21	22	22	23	22	23	20	21	22	21	20	23	24	22	23	22	22	22	23	21	22	24	22	22	24	28	24	25	25	22	23	22	24			
Breadth at the hips	18	18	17	19	18	18	17	18	18	18	17	17	18	17.5	18.3	18.3	17	17	18	17	18	18	19	19	20	25	22	23	23	20	20	19	20			
Depth at the chest	28	27	28	30	30	30	28	27	28.8	28.6	29	31	32	30	33	30	28	28	27	27.5	30	30	32	32	32	36	32	32	32	30	31	31	31			
Height at the withers	50	52	52	54	52	50	54	50	50	49	49	50	49	49	52	52	50	52	52	53	50	52	56	54	54	62	60	60	60	58	56	52	50			
Height at the crop	51	52	52	54	52.5	51	54	50	50	48	49	51	49	49	53	52.5	50	52	52	53		52	55	55	54	60	58	59	58	58	56	53	50			

| | Type IV. | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Type V. |

TABLE VI.—Determining the Area of Land a Carabao can Plow a Day.—(Continued.)

Plowing Rice-paddies (Cabuyao and Mamatid, Laguna).

No.	Sex	Age	Amount of Land plowed a day: Area in sq. meters	Depth in inches	Kinds of Soil	No. of hrs. plowing	Climate	No. of times wetted	Types
54	M	10	6,317	7	Fairly light	11	Cloudy	None	II
55	"	8	5,009	"	"	"	"	"	"
56	"	5	5,118	"	"	"	"	"	"
57	"	6	5,049	"	"	"	"	"	III
58	"	4	6,000	"	"	"	"	"	"
59	"	10	4,030	"	Heavy	"	"	"	"
60	"	11	7,416	"	Fairly light	"	"	"	"
61	"	16	3,000	"	"	"	"	"	"
62	"	9	2,005	"	"	"	"	"	"
63	"	10	2,118	"	"	"	"	"	"
64		10	3,000	"	"	8	"	"	"
65		4½	4,400	"	"	"	"	"	"
66		5	2,215	"	"	7	"	"	"
67		3⅓	2,119	"	"	6	"	"	"
68		4	7,000	"	"	8	"	"	"
69		6	8,115	"	"	"	"	"	"
70		16	3,016	"	"	"	"	"	"
71		4	3,119	"	"	6	"	"	"
72		10	6,040	"	"	8	"	"	"
73		12	2,115	"	"	"	"	"	"
74		6	2,009	"	"	"	"	"	"
75		6	4,600	"	"	"	"	"	"
76		5	4,225	"	"	6	"	"	"
77		10	2,419	"	"	"	"	"	"
78		18	2,034	"	"	"	"	"	"
79		14	2,116	"	"	"	"	"	"
80		10	2,519	"	"	"	Hot	Several times	"
81		12	2,000	"	"	"	"	"	"
82		12	2,118	"	"	"	"	"	"
83		9	3,009	"	"	"	"	"	"
84		7	2,000	6	Heavy	"	"	"	"
85		10	1,300	"	"	"	"	"	"
86		6	4,019	"	"	"	"	"	"
87		8	4,115	"	"	"	"	"	"
88		14	1,440	"	"	"	"	"	"
89		18	2,600	"	"	"	"	"	"
90		10	1,855	"	"	"	"	"	"
91		7	1,906	"	"	"	"	"	"
92		5	1,894	"	"	"	"	"	"
93		20	2,004	"	"	"	"	"	"
94		5	1,907	"	"	"	"	"	"
95		3	1,435	"	"	"	"	"	"
96		3	2,006	"	"	"	"	"	"
97		4	2,000	"	"	"	"	"	"

Plowing Sugar-cane Plantation (Bukal, Laguna).

No.	Sex	Age	Amount of Land plowed a day: Area in sq. meters	Depth in inches	Kinds of Soil	No. of hrs. plowing	Climate	No. of times wetted	Types
98		6	4,000	5	Fairly light	4	Little rain	None	I
99		10	5,068	"	"	"	"	"	"
100		9	3,906	"	"	"	"	"	"
101		18	3,004	"	"	"	"	"	"
102		20	5,000	"	"	"	"	"	"
103		11	4,009	"	"	"	"	"	III
104		5	3,000	4	"	"	"	"	"
105		6	1,005	"	"	"	"	"	"
106		8	2,036	"	"	"	"	"	"
107		10	2,025	"	"	"	"	"	"
108		5	1,005	"	"	"	"	"	"
109		8	5,009	"	"	"	"	"	"
110		20	2,009	"	"	"	Bright sun	Once at noon	"

TABLE VI.—Determining the Area of Land a Carabao can Plow a Day.—(Continued.)

Plowing Sugar-cane Plantation (Bukal, Laguna).

No.	Sex	Age	Amount of Land plowed a day: Area in sq. meters	Depth in inches	Kinds of Soil	No. of hrs. plowing	Climate	No. of times wetted	Types
111		20	1,406	4	Fairly light	4	Bright sun	Once at noon	III
112		10	6,009	"	"	"	"	"	"
113		8	2,000	"	"	"	"	"	"
114		12	2,119	"	"	"	"	"	"
115		12	2,104	"	"	"	"	"	"
116		10	2,100	"	"	"	"	"	"
117		14	2,007	"	"	"	"	"	"
118		8	2,003	"	"	"	"	"	"
119		10	2,000	"	"	"	"	"	"
120		9	2,001	"	"	"	"	"	"
121		6	2,003	"	"	"	"	"	"
122		5	4,025	"	"	"	"	"	"
123		18	6,093	"	"	"	"	"	"
124		16	4,090	"	"	"	"	"	"
125		9	2,036	"	"	"	"	"	"
126		14	2,014	"	"	"	"	"	"
127		7	2,119	"	"	"	"	"	"
128		8	2,335	"	"	"	"	"	"
129		5	1,800	"	"	"	"	"	"
130		10	1,850	"	"	6	"	"	I
131		10	4,923	"	"	"	"	"	"

Plowing Sugar-cane Plantation (Bukal and Canlubang, Laguna).

No.	Sex	Age	Amount of Land plowed a day: Area in sq. meters	Depth in inches	Kinds of Soil	No. of hrs. plowing	Climate	No. of times wetted	Types
132		12	4,000	5	Fairly light	6	Hot	Once at noon	I
133		14	4,600	"	"	"	"	"	"
134		12	3,405	"	"	"	"	"	"
135		9	6,900	"	"	"	"	"	"
136		5	3,405	"	"	"	"	"	"
137		4	3,408	"	"	"	"	"	"
138		6	3,900	"	"	"	"	"	"
139		5	3,000	4	"	4	"	"	II
140		8	4,116	"	"	"	"	"	"
141		10	5,000	"	"	"	"	"	III
142		18	1,446	"	"	"	"	"	"
143		20	2,916	"	"	"	"	"	"
144		25	3,425	"	"	"	"	"	"
145		20	2,114	"	"	"	"	"	"
146		18	6,039	"	"	"	"	"	"
147		9	5,029	"	"	"	"	"	"
148		10	1,072	"	"	"	"	"	"
149		6	1,043	"	"	"	"	"	"
150		4	1,025	"	"	"	"	"	"
151		10	1,016	"	"	"	"	"	"
152		3	1,029	"	"	"	"	"	"
153		9	1,000	"	"	"	"	"	"
154		8	1,448	"	"	"	"	"	"
155		14	2,300	"	"	"	"	"	"
156		11	1,461	"	"	"	"	"	"
157		18	1,223	"	"	"	"	"	"
158		8	1,040	"	"	"	"	"	"
159		5	2,900	"	"	"	"	"	"
160		9	2,112	"	"	"	"	"	"
161		10	1,118	"	"	"	"	"	"
162		12	1,214	"	"	"	"	"	"
163		13	1,225	"	"	"	"	"	"
164		10	2,016	"	"	"	"	"	"
165		6	2,035	"	"	"	"	"	"

TABLE VI.—Determining the Area of Land a Carabao can Plow a Day.—(Continued.)

Plowing Sugar-cane and Corn Plantations (Los Baños, Laguna).

No.	Sex	Age	Amount of Land plowed a day: Area in sq. meters	Depth in inches	Kinds of Soil	No. of hrs. plowing	Climate	No. of times wetted	Types
166		8	2,600	5	Heavy	6	Little rain	None	I
167		10	6,900	"	"	"	"	"	"
168		12	4,003	"	"	"	"	"	"
169		12	4,000	"	"	"	"	"	"
170		10	3,009	4	"	"	"	"	II
171		9	3,900	"	"	"	"	"	"
172		7	3,904	"	"	"	"	"	"
173		4	3,000	"	"	"	"	"	III
174		6	1,448	"	"	"	"	"	"
175		10	2,000	"	"	"	"	"	"
176		18	1 900	"	"	"	"	"	"
177		14	100	"	"	5	"	"	"
178		16	4,065	"	"	"	Hot	Once at noon	"
179		9	1,039	"	"	"	"	"	"
180		7	3,000	"	"	"	"	"	"
181		8	4,023	"	"	"	"	"	"
182		10	4,065	"	"	"	"	"	"
183		5	2,014	"	"	"	"	"	"
184		6	2,018	"	"	"	"	"	"
185		7	1,019	"	"	"	"	"	"
186		8	1,605	"	"	"	"	"	IV
187		18	900	"	"	4	"	"	"
188		12	1,200	"	"	"	"	"	"
189		14	1,440	"	"	"	"	"	"
190		9	1,004	"	"	"	"	"	"
191		10	1,440	"	"	"	"	"	"
192		12	1,350	"	"	"	"	"	"
193		5	1,672	"	"	"	"	"	"
194		6	1,006	"	"	"	"	"	"
195		3	885	"	"	"	"	"	V
196		3	1,004	"	"	"	"	"	"
197		7	893	"	"	"	"	"	"
198		10	916	"	"	"	"	"	"
199		8	918	"	"	"	"	"	"
200		5	1,000	"	"	"	"	"	"

TABLE VII.

DETERMINING THE NUMBER OF HEART BEATS AND BREATHING PER MINUTE.

No.	Sex	Age	No. of heart beats At rest	No. of heart beats At work	No. of breaths At rest	No. of breaths At work
1...	M	8	60	100	48	108
2...	"	8	60	100	48	120
3...	F	5 1/3	72	140	50	128
4...	M	9	68	124	46	130
5...	F	15	60	102	42	130
6...	M	4	60	100	50	120
7...	"	2	78	120	52	104
8...	"	15	60	98	40	126
9...	"	16	70	100	40	130
10...	"	8	62	110	46	112
11...	"	4	76	100	48	108
12...	"	2	78	140	50	110
13...	F	5	63	100	48	120
14...	"	18	59	110	32	128
15...	"	16	60	128	39	120
16...	M	10	72	114	46	110
17...	"	10	74	108	48	108
18...	"	6	78	118	50	106
19...	F	8	70	118	46	118
20...	M	12	65	102	42	120
21...	"	10	72	100	48	116
22...	"	10	72	100	48	130
23...	"	9	76	98	50	105
24...	"	15	64	110	40	136
25...	"	15	64	110	41	124
26...	"	20	52	126	38	140
27...	"	16	62	114	40	115
28...	"	15	64	118	42	109
29...	"	6	78	100	49	110
30...	"	5	74	102	50	104
31...	"	6	76	100	48	121
32...	"	8	70	102	46	130
33...	"	5	78	100	52	107
34...	"	5	78	102	49	102
35...	F	10	64	140	32	140
36...	"	18	59	140	29	160
37...	M	6	74	100	42	128
38...	"	14	60	120	48	124
39...	"	16	58	126	48	108
40...	"	5	78	98	40	112
41...	F	6	72	98	36	140
42...	M	4	78	100	45	98
43...	"	8	65	108	42	102
44...	"	10	62	102	48	110
45...	"	20	54	142	32	140
46...	"	15	63	140	28	160
47...	"	17	56	141	30	124
48...	"	9	70	112	40	102
49...	"	10	68	114	46	104
50...	F	6	78	106	48	104
51...	"	7	72	98	36	102
52...	"	12	70	136	32	100
53...	M	14	69	128	42	108
54...	"	10	73	109	40	124
55...	"	8	74	110	47	109
56...	"	5	76	114	38	100
57...	"	6	70	96	48	120
58...	"	4	78	96	46	110
59...	"	10	70	100	42	136
60...	"	11	71	102	42	140
61...	"	16	70	114	38	160
62...	"	9	74	112	46	140
63...	"	10	70	100	42	138
64...	"	10	72	103	44	120
65...	"	41/2	78	99	48	98
66...	M	5	76	98	48	96
68...	"	4	78	96	48	100
69...	"	6	74	96	46	100
70...	M	16	52	160	32	140
71...	F	4	78	100	48	128
72...	M	10	70	102	42	130
73...	"	12	70	104	46	125
74...	"	6	74	106	48	120
75...	"	6	76	108	48	108
76...	F	5	78	102	42	120
77...	M	10	70	108	38	140
78...	"	18	60	140	29	142
79...	"	14	62	128	32	140
80...	"	10	64	120	40	120
81...	"	12	62	128	40	120
82...	"	12	63	120	42	118
83...	"	9	78	100	48	138
84...	"	7	78	100	49	120
85...	"	10	70	102	28	140
86...	"	6	74	104	32	140
87...	"	8	78	102	32	140
88...	"	14	68	138	29	160
89...	"	18	64	140	28	160
90...	"	10	62	140	40	110
91...	"	7	70	120	42	108
92...	"	5	78	108	48	112
93...	"	20	60	110	28	140
94...	"	5	74	108	42	108
95...	"	3	78	120	48	110
96...	"	3	78	118	48	110
97...	"	4	74	110	46	109
98...	"	6	76	110	42	110
99...	"	10	62	120	38	120
100...	"	9	72	120	40	108
101...	"	18	58	146	28	138
102...	"	20	52	148	28	140
103...	"	11	68	132	32	120
104...	"	5	74	120	48	120
105...	M	6	78	108	32	142
106...	"	8	72	102	34	140
107...	"	10	70	108	30	120
108...	F	5	78	110	38	108
109...	"	8	78	110	32	124
110...	"	20	58	98	28	130
111...	"	20	52	98	28	148
112...	M	10	64	108	30	120
113...	"	8	68	120	32	124
114...	"	12	62	110	32	110
115...	"	12	60	110	32	102
116...	"	10	70	102	40	110
117...	"	14	60	108	30	160
118...	"	8	72	108	38	140
119...	"	10	70	140	32	120
120...	"	9	74	120	38	102
121...	"	6	78	106	40	100
122...	"	5	78	108	42	100
123...	"	18	62	110	28	142
124...	"	16	62	110	30	140
125...	"	9	72	112	45	108
126...	"	14	60	108	38	120
127...	F	7	70	112	40	104
128...	"	8	70	114	42	102
129...	M	5	78	98	45	100
130...	"	10	70	102	38	106
131...	"	10	70	100	38	110

TABLE VII.—Determining the Number of Heart Beats and Breathing per Minute.—(Continued.)

No.	Sex	Age	No. of heart beats At rest	No. of heart beats At work	No. of breaths At rest	No. of breaths At work
132 ..	M	12	68	120	30	120
133...	"	14	60	110	30	132
134...	"	12	62	106	32	130
135...	"	9	72	140	40	100
136...	"	5	74	110	48	100
137...	"	4	78	109	45	100
138...	"	6	74	120	46	102
139...	"	5	78	98	48	98
140...	M	8	70	140	40	108
141...	"	10	62	120	38	110
142...	"	18	58	140	32	106
143...	"	20	56	160	32	128
144...	"	25	52	108	30	128
145...	"	20	56	108	28	128
146...	"	18	58	102	29	112
147...	"	9	70	110	32	110
148...	"	10	70	104	40	110
149...	"	6	72	98	48	120
150...	F	4	78	98	48	120
151...	"	10	70	102	42	160
152...	"	3	78	160	50	102
153...	M	9	72	120	46	104
154...	"	8	72	120	48	102
155...	"	14	68	140	28	120
156...	"	11	70	102	30	118
157...	"	18	60	102	28	140
158...	F	8	64	110	32	104
169...	M	5	65	140	36	102
160...	"	9	62	110	34	108
161...	"	10	64	108	38	106
162...	"	12	60	124	34	120
163...	"	13	62	120	38	118
164...	"	10	68	124	40	100
165...	F	6	74	106	42	100
156...	"	8	70	108	48	108
167...	M	10	70	98	40	105
168...	"	12	68	99	38	103
169...	"	12	68	98	38	110
170...	M	10	62	100	32	110
171...	"	9	70	102	40	106
172...	"	7	70	106	42	120
173...	"	4	72	104	48	140
174...	"	6	74	100	46	120
175...	"	10	68	100	38	140
176...	"	18	60	104	28	120
177...	"	14	62	106	28	132
178...	"	16	60	120	30	140
179...	"	9	70	110	32	108
180...	"	7	72	108	32	102
181...	"	8	70	110	30	104
182...	"	10	70	120	36	109
183...	"	5	78	110	48	100
184...	"	6	74	106	48	100
185...	"	7	70	104	46	102
186...	"	8	70	110	42	106
187...	"	18	58	120	28	120
188...	"	12	60	140	29	110
189...	"	14	60	128	28	118
190...	F	9	68	108	40	104
191...	M	10	68	120	38	106
192...	"	12	68	120	32	110
193...	"	5	78	114	46	100
194...	"	6	78	120	48	100
195...	"	3	78	126	48	100
196...	"	3	78	140	48	100
197...	"	7	74	160	40	102
188...	"	10	70	120	38	109
199...	"	8	72	120	32	106
200...	"	5	78	120	48	102
201...	"	3 ms.	80		52	
202...	"	15 da.	79		53	
203...	"	1 ms.	80		50	
204...	F	2 mos. 10 da.	80		52	
205...	"	1½ mo.	80		52	

TABLE VIII.

Determining the Weight of Load which a Carabao can Pull.

Observation in the Provinces.

No.	Sex	Kinds of load	Amount	Weight	Rate of travel per kilometer: With load	Rate of travel per kilometer: Without load
				lbs.	min.	min.
1	M	Rock, bldg. bridge	1 car load	1,503	23	18
2	"	"	"	1,600	25	19
3	"	"	"	1,500	25	19
4	"	"	"	1,002	25	14
5	"	"	"	2,000	26	18
6	F	"	"	943	26	14
7	"	"	"	960	26	18
8	"	"	"	962	24	16
9	M	"	"	985	24	19
10	"	"	"	2,010	25	18
11	M	Rock, bldg. road	1 car load	892	25	19
12	"	"	"	940	26	18
13	"	"	"	985	24	19
14	"	"	"	961	26	19
15	"	"	"	809	26	20
16	"	"	"	1,021	24	18
17	"	"	"	1,090	25	18
18	"	"	"	980	24	16
19	"	"	"	949	26	18
20	"	"	"	1,003	26	18

TABLE VIII.—Determining the Weight of Load which a Carabao can Pull.—(Continued.)

No.	Sex	Kinds of load	Amount	Weight	Rate of travel per kilometer: With load	Rate of travel per kilometer: Without load
		Observation in Provinces				
				lbs.	min.	min.
21	M	Bock, bldg. bridge	1 car load	862	25	19
22	"	"	"	941	26	19
23	"	"	"	983	26	19
24	"	"	"	914	26	18
25	"	"	"	916	26	14
26	"	"	"	2,000	24	19
27	"	"	"	1,609	25	20
28	"	"	"	1,303	25	19
29	"	"	"	1,500	25	18
30	"	"	"	1,306	28	19
31	"	"	"	1,900	26	18
32	"	"	"	985	26	16
33	F	"	"	848	26	18
34	M	Unhulled rice	10 sacks	555	30	22
35	"	"	"	555	30	22
36	"	"	"	555	30	22
37	F	"	12 sacks	666	28	20
38	"	"	12 "	666	28	19
39	"	"	10 "	555	25	20
40	"	"	10 "	555	25	19
41	M	"	15 "	825	28	21
42	"	"	15 "	825	26	19
43	"	"	17 "	943	28	22
44	"	"	10 "	555	24	19
45	"	"	10 "	555	24	19
46	"	"	10 "	555	26	19
47	"	"	7 "	389	26	22
48	"	"	17 "	943	24	19
49	F	"	10 "	555	26	21
50	M	"	15 "	825	24	19
51	"	"	15 "	825	26	20
52	"	"	17 "	943	26	21
53	"	Threshed rice	12 "	1,332	24	18
54	"	"	12 "	1,332	23	18
55	"	"	12 "	1,332	24	18
56	"	"	10 "	1,000	23	18
57	"	"	11 "	1,300	24	18
58	"	"	12 "	1,332	23	18
59	"	"	"	1,332	26	20
60	"	"	"	1,332	23	18
61	"	"	"	1,332	24	20
62	"	"	"	1,332	24	18
63	"	"	11 "	1,300	23	18
64	"	"	"	1,300	23	18
65	"	"	"	1,300	26	20
66	"	"	"	1,300	24	18
67	"	"	12 "	1,332	24	18
68	"	"	"	1,332	23	18
69	"	"	"	1,332	26	20
70	"	"	"	1,332	24	19
71	"	"	"	1,332	26	18
72	"	"	"	1,332	26	18
		Observation in Manila				
74	"	Wood for fuel	50 bundles	2,000	25	16
75	"	"	"	"	23	14
76	"	"	"	"	18	14
77	M	Wood for fuel	50 bundles	2,000	17	13
78	"	"	"	"	25	12
79	"	"	"	"	23	16
80	"	"	"	"	23	14
81	"	"	"	"	24	14
82	"	"	"	"	18	14
83	"	"	"	"	18	15
84	"	"	"	"	16	15
85	"	"	"	"	18	15
86	"	"	"	"	18	14
87	"	"	"	"	18	14
88	"	"	"	"	18	14
89	"	"	"	"	18	14
90	"	"	"	"	16	14
91	"	"	"	"	18	16
92	"	"	"	"	18	16
93	"	"	"	"	18	16
94	"	"	"	"	16	12
95	"	Threshed rice	20 sacks	2,042	25	16
96	"	"	"	"	25	16
97	"	"	"	"	23	16
98	"	"	"	"	23	14
99	"	"	"	"	24	16
100	"	"	"	"	24	16
101	"	"	"	"	25	16
102	"	"	"	"	24	12
103	"	"	"	"	24	12
104	"	"	"	"	23	12
105	"	"	"	"	21	12
106	"	"	18 sacks	"	18	12
107	"	"	"	"	18	14
108	"	"	"	"	16	12
109	"	"	"	"	16	12
110	"	"	"	1,838	18	14
111	"	"	"	"	23	16
112	"	"	"	"	23	16
113	"	"	"	"	18	14
114	"	"	"	"	18	12
115	"	"	20 sacks	2,042	18	12
116	"	"	"	"	16	12
117	"	"	"	"	18	14
118	"	"	"	"	22	16
119	"	"	"	"	22	14
120	"	"	"	"	23	15
121	"	"	"	"	24	15
122	"	"	"	"	24	16
123	"	"	"	"	24	15
124	"	"	"	"	24	15
125	"	"	"	"	26	16
126	"	"	"	"	24	16
127	"	"	"	"	24	16
128	"	"	"	"	18	12
129	"	Petroleum	32 bxs.	2,080	18	12
130	"	"	"	"	18	14
140	"	"	"	"	18	14
131	"	"	"	"	18	14
132	"	"	"	"	24	16
133	"	"	"	"	25	16
134	"	"	"	"	24	16

TABLE VIII.—Determining the Weight of Load which a Carabao can Pull—(Continued.)

Observation in Manila.

No.	Sex	Kinds of load	Amount	Weight	Rate of travel per kilometer: With load	Rate of travel per kilometer: Without load
				lbs.	min.	min.
135	M	Petroleum	32 bxs.		23	16
136	"	"	"	2,080	21	16
137	"	"	"	"	22	18
138	"	"	"	"	22	18
139	"	"	"	"	18	12
140	"	"	"	"	18	12
141	"	"	"	"	16	12
142	"	"	"	"	16	12
143	"	"	"	"	18	12
144	"	"	"	"	20	14
145	"	Tobacco leaves	20 bundles	1,998	23	18
146	"	"	"	"	28	18
147	"	"	"	"	25	18
148	"	"	"	"	28	16
149	"	"	"	"	26	16
150	"	"	"	"	21	14
151	"	"	"	"	23	14
152	"	"	"	"	21	14
153	"	"	"	"	22	14
154	"	"	"	"	18	14
155	"	"	"	"	18	14
156	"	"	"	"	18	14
157	"	"	"	"	18	14
158	"	"	"	"	18	14
159	"	"	"	"	18	14
160	"	"	"	"	14	12
161	"	"	"	"	16	12
162	"	"	"	"	20	16
163	"	"	"	"	20	16
164	"	"	"	"	20	16
165	"	"	"	"	20	16
166	"	"	"	"	20	16
167	"	"	"	"	20	16
168	"	"	"	"	23	18
169	"	"	"	"	23	18
170	"	"	"	"	23	18
171	"	"	"	"	23	14
172	"	"	"	"	21	12
173	"	"	"	"	21	14
174	M	Tobacco leaves	20 bundles	1,998	23	14
175	"	"	"	"	18	12
176	"	"	"	"	18	12
177	"	"	"	"	18	12
178	"	"	"	"	18	12
179	"	"	"	"	18	12
180	"	"	"	"	18	14
181	"	Threshed rice	20 sacks	2,042	21	16
182	"	"	"	"	21	16
183	"	"	"	"	23	18
184	"	"	"	"	24	18
185	"	"	"	"	24	18
186	"	"	"	"	26	18
187	"	"	"	"	20	16
188	"	"	"	"	20	16
189	"	"	"	"	20	16
190	"	"	"	"	21	16
191	"	"	"	"	21	16
192	"	"	"	"	20	16
193	"	"	"	"	23	16
194	"	"	"	"	23	14
195	"	"	"	"	23	14
196	"	"	"	"	21	14
197	"	"	"	"	21	14
198	"	"	"	"	23	18
199	"	"	"	"	23	14
200	"	"	"	"	20	16
201	"	"	"	"	20	16
202	"	"	"	"	20	14
203	"	"	"	"	23	18
204	"	"	"	"	23	18
205	"	"	"	"	23	18
206	"	"	"	"	21	16
207	"	"	"	"	21	14
208	"	"	"	"	21	14
209	"	"	"	"	21	12
210	"	"	"	"	21	12

Adaptability of Certain Philippine Plants to Propagation by Cuttings and Marcottage

By Jose C. Miraflores

Thesis presented for graduation from the College of Agriculture, No. 37.

Plants are propagated by means of seeds and by buds or cuttings. Farmers and gardeners have employed many different methods in the propagation of plants but these are really only modifications of the two general ones. Most farm crops and garden vegetables are grown from seeds but in the case of shrubs and fruit trees vegetative methods of propagation are more advisable.

In America propagation by means of buds has revolutionized almost all orchard work and the results are the admiration of the world. American fruits are exported to every part of the globe and often bring better prices than locally grown ones of the same kinds. The Filipino horticulturist usually propagates his trees by seeds. Layering (Marcottage) is practiced to a certain extent, but even this is not well done. Growers make a girdle ring around the branch and leave it until the callus begins to form, when they tie a ball of coconut fibers around the ring; sometimes they use soil enclosed in the coconut husk. After this the layer is left without further attention. With this practice it takes about two years before they detach the branch from the mother plant.

In the Philippines we have a few plants which are universally grown with ease by vegetative propagation. Some of these are ceruelas (Spondias purpurea L.), kapok (Ceiba pentandra L.), and dapdap (Erythrina indica Lam.), the limbs of all of which are cut off and stuck into the ground. Some people plant these around the borders of their land, thus using them at the same time as fences. Branches are cut from one to three feet long and set at a convenient distance from each other. Experience has shown that the best time for planting all these cuttings is in the beginning of the rainy season.

Certainly there are many fruits in the Philippines, which at their best could command high market prices, but which commonly yield little profit, because of their being small and inferior in quality. The reasons for this are: first, that native farmers do not propagate their good trees vegetatively, the only sure way of perpetuating the individual character; second, they never practice careful selection; and third, they do not understand the ordinary principles of plant improvement. We sometimes find in the markets fruits of exceptional value, the propagation of which would pay if we could locate the parent trees, and propagate them vegetatively. It is a much better practice to produce our nursery stock locally, than to import from the outside, which involves the necessity of acclimatization, and also carries with it the possiblity of introducing dangerous pests.

With the object of determining the adaptability of certain Philippine plants to propagation by cuttings and by marcottage, the following series of experiments was undertaken:

Thirty boxes (60 cm. x 40 cm. x 15 cm.) were placed in two rows in the propagating house at the College nursery. The boxes were made in such a way that the drainage was as perfect as possible. Common garden soil mixed with well rotted organic matter was screened through a 2 millimeter sieve and the sifted soil was put into fifteen

boxes. In the other fifteen boxes, only clean sand free from organic matter was used. Two plots (2 m. x 1 m.) were made under the shade of trees. The soil was thoroughly pulverized and the plots were raised about 20 cm. above the surface of the ground so as to insure perfect drainage. In August, 1914, two other plots (2 m. x 1 m.) were made in one of the propagating houses. These plots were excavated to a depth of fifty centimeters. Fresh horse manure was placed in these holes until the level was only about 15 cm. below the surface of the ground. One plot was then filled with a mixture of equal quantities of sand and common garden soil and the other plot with ordinary soil containing decayed vegetable matter. The object of putting fresh horse manure in the bottoms of these plots was to generate heat from the fermenting manure, for the purpose of stimulating the callousing of the cuttings. On November 1, 1914, a series of plot experiments was begun. Thirty ten-inch pots, filled with sand of various grades taken from the creek, were placed under the propagating house.

The plants used in these experiments were: *Morus alba* (Mulberry), *Manihot Glaziovii* (Ceara rubber), *Ficus ulmifolia* (Isis), *Antidesma* sp. (Bignay pogo), *Antidesma bunius* (Bignay), *Eugenia* sp. (Macopa), *Eugenia jambolana* (Duhat), *Allamanda*, *Coffea arabica* (Coffee), *Theobroma Cacao* (Cacao), *Ficus Carica* (Adriatic figs), *Achras Sapota* (Chico), *Anona reticulata* (Anona), *Anona squamosa* (Atis), *Artocarpus integrifolia* (Nanca), *Averrhoa Bilimbi* (Camias), *Averrhoa Carambola* (Bilimbing), *Lansium domesticum* (Lanson), *Cananga odorata* (Ylang-Ylang), *Derris philippinensis*, *Paramigyna longepedunculata*, *Guioa* sp., *Vitis vinifera* (American grapes), *Sandoricum Koetjape* (Santol), *Talauma villariana*, *Bignonia magnifica*, and *Passiflora quadrangularis*. Of each of these plants, one hundred soft and one hundred hard-wood cuttings about 15 cm. long were made and set under the different conditions of the propagating plots. The end of the shoot to be placed in the ground was cut slantingly across with a sharp clean knife just below the leaf bud. If the internodes were long, the cutting was made in such a way that each shoot had two or three buds. All the leaves were removed, except the unfolded ones in the case of soft-wood cuttings. Two-thirds of the length of each cutting was inserted in the soil in a slanting position, leaving only about one-third above the surface.

On each of the above-named plants, except *Cananga odorata*, five or six marcottages were set. The branches were girdled and enclosed in a soil rich in organic matter, the whole being wrapped with coconut husks. Different ways of cutting were tried, such as by removing only one-half of the bark encircling the stem of the plant for a length of about five centimeters, by removing a complete ring of bark about five centimeters wide, and by cutting half way through the wood in the shape of the letter V; also by cutting through the wood lengthwise and then introducing a piece of wood or stone so as to hold the stem open. The serpentine layer, suggested by Bailey in his Nursery Book, was tried on vines; the vine was bent and several portions were covered, the intervals being left above the ground. As to the time of rooting there was no advantage in this over other methods described above. The serpentine layer is probably cheaper than any of the others and is to be recommended in the propagation of various vines.

The cuttings were set one centimeter from each other, in rows about five centimeters apart. The beds were kept in a moderately moist condition.

The cuttings should never be pushed into the soil, because that may injure the part introduced, especially the cut end. The proper way of setting them is to trench the plots in rows and place the cuttings one by one at the desired distance and then fill around them with soil; or to introduce first into the soil to the desired depth a round piece of wood with pointed end with a diameter of about three centimeters, afterwards placing the cutting in this hole. The soil around the cutting should be pressed gently.

Watering should be done with judgment. In the dry season the plots in the open air are watered every day. A common garden sprinkler is best adapted for this purpose. In the case of marcottage H. F. Macmillan in his Handbook of Tropical Gardening and Planting suggests that a pot should be hung over the layer and the hole at the bottom of the pot connected with a rope to the layer, so that the water, with which the pot is constantly supplied, oozes out slowly and distributes itself through the whole layer. In places where bamboo is abundant a bamboo tube is very good for this purpose, for, besides being more economical, it is easier to handle.

In these experiments the tubes were cut to a length of two internodes; one end being open and the other closed. Two opposite holes were made near the edge of the open end so that it could be tied up with wire or string; and in the bottom a hole one millimeter in diameter was made as an outlet for the water. Then the tube was hung at a distance of about ten centimeters over the marcottage and the small wire tying the latter was introduced into the hole. In this way the water trickled down the wire and kept the whole in a constantly moist condition. In very dry weather the tube was filled with water twice a day, once in the morning and once in the afternoon, but in normal times once every morning only.

The cuttings which have made roots should be transferred directly to pots or to propagating beds already prepared, and there spaced ten centimeters or more between plants, and twenty centimeters or more between rows. In handling, great care should taken not to destroy or injure the young roots, because otherwise the growth will be checked and a large percentage of the plants will fail to survive. In removing the shoots from the plots, first introduce into the soil a piece of flat wood or bamboo, deeper than the setting of the cuttings, and then pry them up. The soil and the cuttings come up together and the roots are not liable to injury. If the soil is too firm or hard it should be watered before the plants are removed. If pots be used, bamboo tubes about thirty centimeters long are advisable, in case thorough drainage is provided. The advantages of bamboo tubes over the earthen pots are:—first, that after one year they are quite decayed and can therefore go with the plants in setting them in their permanent places in the field, without the trouble of removing them; second, the handling during transportation is easy; and third, the cost is much less than that of clay pots.

The cuttings set in plots where bottom heat from decaying horse manure was applied formed calluses more quickly than those in the other plots, but they failed to strike root as well. Some of the plants which succeeded in striking root in the other plots failed to do so with bottom heat. Perhaps this is due to the fungi or bacteria in the manure, which may have attacked the raw ends of the cuttings. Rot proceeded from the bottom to the surface of the

ground. The highest temperature of the manure in the bottom of these plots was 43° C., gradually dropping to 30° C., while the temperature of the air varied from 21° C. to 28° C. The temperature of 43° C. continued only for four to six days. Cuttings which were infected with disease usually failed to strike root, or if they did, produced only weak plants. This was especially true with cuttings of *Theobroma Cacao*, *Coffea arabica*, *Ficus Carica*, *Ficus ulmifolia* and *Vitis vinifera*.

Termites are destructive to both cuttings and marcottages. The latter are also injuriously attacked by small black ants. The small black ants do not destroy the coconut husk as do the termites, but they make their home inside and eat the young roots as soon as they appear. In my experiments, crude oil and naphthaline proved successful preventatives against these enemies. The crude oil was applied under the boxes and around the plots. The trunk of the tree, and the base of the branch where the marcottage was attached, were also painted. This kept the termites from coming up. The naphthaline was applied by scattering it over the surface of the plots and around the borders.

The results of my experiments are summarized as follows:

Morus alba (Mulberry) was tested nine times, setting the cuttings under different conditions, and the results show that it can be easily propagated by means of cuttings as well as by marcottages. The cuttings of hard wood are best for propagation and they root better in the plots of ordinary garden soil. The diameter of the cuttings ranged from 5 to 20 millimeters. The marcottages were prepared July 26, 1913, and struck root by August 24, 1913, requiring 29 days from the time of setting.

Experiments with *Manihot Glaziovii* (Ceara rubber) were repeated twelve times, setting the cuttings under the different conditions described above. This tree can be propagated successfully by means of cuttings as well as by marcottages. In the plots outside, with ordinary garden soil, the hard wood cuttings with a diameter ranging from five to thirty millimeters, have shown themselves best for propagation. The marcottages were set September 29, 1913, and rooted on November 24, 1913, requiring fifty-six days from the time of setting. The diameter of the branches ranged from two to five centimeters.

Ficus ulmifolia was tried seventeen times under all of the different conditions described above and showed that it can be propagated by means of cuttings as well as by marcottages. This plant will root better if the hollow inside of the shoot be previously filled. Hard-wood cuttings with the diameter ranging from five to twenty millimeters rooted the best. The marcottages were set September 20, 1913, and rooted by November 4, 1913, requiring 45 days from the time of setting. The diameter of the branches used ranged from 2 to 4.5 centimeters. The experiment was repeated July 3, 1914, and the plant rooted by August 12, 1914, requiring 40 days from the time of setting.

Antidesma sp. (Bignay pogo) was tried nine times, setting the cutting both in sand and in common garden soil, and the results showed that it can be propagated successfully by means of cuttings as well as by marcottages. Soft-wood cuttings with diameters ranging from 2 to 5 millimeters rooted better in the plots outside with ordinary garden soil than under any of the other conditions described above. The marcottages were prepared September 14,

1913, and had rooted by December 4, 1913, requiring 81 days from the time of setting. The diameter of the branches ranged from one to four centimeters.

Antidesma bunius (Bignay) was tested sixteen times, setting the cuttings under the different conditions described above, and the results showed that it can be propagated by means of cuttings, as well as by marcottages. A few cuttings with diameters ranging from 4 to 15 millimeters rooted better in sandy soil. The marcottages were prepared August 4, 1913, and had rooted by November 7, 1913, requiring 95 days from the time of setting. The diameter of the branches used ranged from to 2 to 4.5 centimeters.

Eugenia sp. (Macopa) was tried fifteen times, setting the cuttings under all of the different conditions described above, the results showing that it can be propagated by means of cuttings, as well as by marcottages, but by the former method only a few struck root. Hard-wood cuttings with a diameter of from 5 to 20 millimeters succeeded in sandy soil. The marcottages were prepared September 6, 1913, and had rooted by December 28, 1913, requiring 113 days from the time of setting. The diameters of the branches used ranged from 1.5 to 4 centimeters. This experiment was repeated July 4, 1914, and the layers rooted by October 10, 1914, requiring only 98 days.

Eugenia jambolana (Duhat) was tried seven times under the different conditions described above and the results showed that it can be propagated by means of cuttings, as well as by marcottages, though by the former method only a small percentage took root. The hard-wood cuttings with diameters ranging from 4 to 18 millimeters struck root better in the sandy soil. The marcottages were prepared July 10, 1914, and rooted by October 8, 1914, requiring 90 days from the time of setting. The diameters of the branches used ranged from 2 to 5 centimeters.

Experiments with *Allamanda* were repeated nine times, setting the cuttings both in sand and in common garden soil, and the results showed that it can be easily propagated by means of cuttings as well as by marcottages. The cuttings with diameters ranging from 4 to 15 millimeters rooted better in common garden soil than in sand The marcottages were prepared September 23, 1913, and rooted by October 28, 1913, requiring 35 days from the time of setting. The diameters of the stems used ranged from 0.8 to 2 centimeters. This was repeated August 17, 1914, by the serpentine method, and the layers rooted by September 26, 1914, requiring 40 days from the time of setting.

Coffea arabica (Coffee) was tested fifteen times, setting the cuttings under the different conditions described above, and the results show that it can be propagated by means of cuttings, as well as by marcottages, but in the former case only a small percentage was successful. The hardwood cuttings free from disease and with diameters ranging from 4 to 15 millimeters struck root most often in the sandy soil. The marcottages were prepared August 14, 1913, and rooted by December 10, 1913, requiring 118 days from the time of setting. The diameters of the branches used ranged from 1 to 4 centimeters.

Experiments with *Theobroma Cacao* (Cacao) were repeated fifteen times, setting the cuttings under the different conditions described above. The results show that this plant can be propagated by means of cuttings, as well as by marcottages, but by the former method only a small percentage struck root. The hard-wood cuttings with diameters ranging from 5 to 20 milli-

meters rooted in sandy soil. Shoots infected with disease were not able to strike root. The marcottages were prepared August 16, 1913, and rooted by December 14, 1913, requiring 120 days from the time of setting. The diameters of the branches used ranged from 2 to 5 centimeters.

Experiments with *Ficus Carica* (Adriatic figs) were repeated four times, setting the cuttings in sandy soil, and the results show that they can be propagated by means of cuttings, as well as by marcottages. The cuttings with diameter ranging from 0.6 to 2.5 millimeters were found most successful. The marcottages were prepared August 13, 1913, and rooted by October 17, 1913, requiring 65 days from the time of setting. The diameter of the branches used was 2.4 centimeters.

Experiments with *Achras Sapota* (Chico) were repeated sixteen times, setting the cuttings under the different conditions described above. Several cuttings calloused but were unable to strike root. The marcottages were set July 9, 1913, and rooted by November 4, 1913, requiring 118 days from the time of setting. The diameter of the branches used ranged from 1.5 to 4 centimeters.

Anona reticulata (Anona) was tested sixteen times, setting the cuttings under the different conditions described above, and all were successful. The marcottages were prepared July 2, 1913, and had rooted by November 29, 1913, requiring 150 days. The diameters of the branches used ranged from 3 to 6.5 centimeters.

Experiments with *Anona squamosa* (Atis) were tried seven times, setting the cuttings under the different conditions described above. Several hardwood cuttings calloused in the sandy soil but were unable to strike root. The marcottages were prepared July 9, 1914, and had rooted by November 12, 1914, requiring 126 days from the time of setting. The diameters of the branches used ranged from 2 to 4.5 centimeters. These marcottages were not watered regularly during the hot weather.

Experiments with *Artocarpus intergrifolia* (Nanca) were repeated sixteen times under the different conditions described above, but all were unsuccessful. The marcottages were prepared July 10, 1913, and rooted by December 28, 1913, requiring 171 days. Out of 6, only 2 branches struck root. The diameters were 3 and 4.5 centimeters.

Averrhoa Bilimbi (Camias) was tried fifteen times, setting the cuttings under the different conditions described above. Several cuttings calloused but were finally unsuccessful. The marcottages were prepared July 13, 1913, and rooted by November 4, 1913, requiring 114 days from the time of setting. The diameters of the branches used ranged from 2 to 5 centimeters.

Experiments with *Averrhoa Carambola* (Bilimbing) were repeated fifteen times under the different conditions described above. Several hard-wood cuttings calloused but failed to strike root. The marcottages were prepared August 3, 1913 and rooted by December 2, 1913, requiring 121 days from the time of setting. The diameters of the branches used ranged from 2.5 to 5 centimeters. Another branch marcotted July 22, 1914, had rooted by November 14, 1914, requiring 115 days.

Lansium domesticum (Lanson) was tested fifteen times under the different conditions described above, but did not strike root at all. Several hard-wood cuttings calloused but none made roots. The marcottages were prepared July 6, 1913, and rooted by November 17, 1913, requiring 134 days from the time of setting. The diameters of the

branches used ranged from 1 to 4.5 centimeters.

Experiments with cuttings of *Cananga odorata* (Ilang-Ilang) were repeated sixteen times under the different conditions described above, but all were unsuccessful. The marcottages were set August 3, 1913, and rooted by December 17, 1913, requiring 136 days from the time of setting. Out of 4, only one made roots. The diameter of the branch in the successful case was 5.4 centimeters.

Derris philippinensis was tested sixteen times, setting the cuttings under the different conditions described above, and the results showed that it can be propagated both by cuttings and marcottages, though by the former method only a very small percentage was successful. The hard-wood cuttings with a diameter ranging from 4 to 10 millimeters struck roots in sandy soil. The marcottages were prepared September 14, 1913, and rooted by November 21, 1913, requiring 68 days from the time of setting. The diameters of the stems used ranged from 1 to 3 centimeters. It was tried again August 14, 1914, by the serpentine method and rooted by November 17, 1914, requiring 95 days from the time of setting.

Experiments with *Paramigyna longepedunculata* were repeated fifteen times, setting the cuttings under the different conditions described above, but they failed to strike root. Very few hard-wood cuttings calloused in sandy soil. The marcottages were prepared August 7, 1913, and rooted by December 13, 1913, requiring 128 days from the time of setting. The diameters of the stems used ranged from 0.8 to 2.5 centimeters.

Experiments with cuttings of *Guioa* sp. were repeated seventeen times, setting the cuttings under the different conditions described, but all were unsuccessful. Only a few of the hard-wood cuttings calloused and these were unable to strike root. The marcottages were set July 19, 1913, and rooted by November 3, 1913, requiring 107 days from the time of setting. The diameters of the branches used ranged from 1.5 to 5 centimeters.

Experiments with cuttings of *Sandoricum Koetjape* (Santol) were repeated seventeen times, setting the cuttings under the different conditions described above, but all were unsuccessful. A few cuttings calloused but failed to strike root. The marcottages were prepared July 26, 1913, and rooted by November 21, 1913, requiring 118 days from the time of setting. This experiment was tried again August 4, 1914, and the plants rooted by November 21, 1914, requiring 109 days from the time of setting. The diameters of the branches used ranged from 1.5 to 6 centimeters.

Experiments with cuttings of *Talauma villariana* were repeated sixteen times under the different conditions described above, but all were unsuccessful. The marcottages were prepared July 14, 1913, and rooted by November 7, 1913, requiring 116 days from the time of setting. Out of 5, only two succeeded in striking root. The diameters of these branches were 2.3 and 4.7 centimeters.

Experiments with *Vitis vinifera* (American grapes) were repeated five times, setting the cuttings in sandy soil in pots, showing that this plant can be readily propagated by means of cuttings. The diameters of the cuttings used ranged from 5 to 14 millimeters.

Experiments with cuttings of *Bignonia magnifica* were repeated six times under the different conditions described above, but all were unsuccessful. The cuttings calloused in sandy and garden soil but were not able to root. The marcottages were prepared August 6, 1914, and rooted by September 29, 1914, requir-

ing 54 days from the time of setting. The diameters of the stems ranged from 0.5 to 1.5 centimeters. At the same time the serpentine method of layering was tried. The experiment was started August 10, 1914, and the stem had rooted by October 14, 1914, the plant requiring 65 days from the time of setting.

Experiments with *Passiflora quadrangularis* were repeated four times under the different conditions described above, the results showing that it can be easily propagated by means of marcottages. The cuttings will root either in sand or in ordinary common garden soil. The diameters of the cuttings used ranged from 6 to 18 millimeters. The marcottages were prepared September 4, 1914, and rooted by October 15, 1914, requiring 41 days from the time of setting.

The setting of the marcottages should be done with care. The soil inside the husk should be quite compact so that it can not sift or shake out, and the husks must be tied in a fixed position to prevent detachment or turning around the branch. The soil inside of the husk should be watched carefully in order that it may not become too wet or too dry because these conditions prevent successful rooting.

Other attempts were made to grow cuttings by first girdling the branches of those plants that had not been able to strike root by ordinary methods. The object was to interrupt the rapid movement of digested food material toward the roots or basal parts. The food will accumulate above the ring and this may favor the formation of cellular matter which gives rise to a mass of tissue known as a callus. When the wound was entirely covered with callus the branches were detached from the mother plant and set as usual along with other cuttings. By this method, with *Bignonia magnifica*, out of 10 cuttings planted in sand in pots, 8 rooted and 2 failed. Hard-wood cuttings rooted better on the whole than soft-wood cuttings, except in the case of Antidesma sp. (Bignay pogo) with which the contrary was true.

Conclusions

From the above records we conclude that *Morus alba* (Mulberry), *Manihot Glaziovii* (Ceara rubber), *Ficus ulmifolia* (Isis), *Antidesma* sp. (Bignay pogo), *Allamanda*, *Vitis vinifera* (American grapes), *Passiflora quadrangularis* and *Ficus Carica* (Adriatic figs) can be successfully propagated both by cuttings and marcottages, apparently about equally readily.

Antidesma Bunius (Bigany), *Eugenia jambolana* (Duhat), *Coffea arabica* (Coffee), *Bignonia magnifica*, *Theobroma Cacao* (Cacao), *Derris philippinensis*, and *Eugenia* sp. (Macopa) can be propagated by means of cuttings, but it is doubtful yet whether this method can be used on a commercial scale without radical modifications. All of these can be propagated by marcottage.

Achras Sapota (Chico), *Anona reticulata* (Anona), *Anona squamosa* (Atis), *Artocarpus integrifolia* (Nanca), *Averrhoa Bilimbi* (Camias), *Averrhoa Carambola* (Bilimbing), *Lansium domesticum* (Lanson), *Guioa* sp., *Sandoricum Koetjape* (Santol), *Talauma villariana*, *Paramigyna longepedunculata* and *Cananga odorata* (Ilang-Ilang), can be propagated by means of marcottage.

The best time for propagating the above named plants in this region by means of cuttings is in the months of October to January, and by means of marcottages at the beginning of the rainy season. The marcottages should be prepared about the month of June, so that they will be naturally moist all the time. When dry weather comes,

watering should always be attended to, otherwise the roots will soon die.

When the cuttings and the marcottages have taken root, they should not be planted directly in the field, but in pots or nursery beds with rich soil and should be partially shaded.

Termites and small black ants are the great enemies of cuttings and marcottages, but their work can be prevented by applying crude oil or naphthaline. The crude oil should be put under the boxes, and around the margin of the plots, and should be applied around the trunks of the trees and at the bases of the branches where layers are attached. The naphthaline should be scattered under the boxes and on the surface of the soil.

Propagation by means of cuttings and marcottages gives quicker results than by seeds. In the case of *Achras Sapota* (Chico) propagation by marcottage may give fruit three years after the time of the detaching of the branch from the mother plant. There is also the inestimable advantage of getting progeny very similar in character to the parent plant.

The writer wishes to express his thanks to Prof. Charles F. Baker for valuable advise and help.

References

1. Bailey "The Nursery Book," Fourteenth Edition (1910), pp. 35-72.

2. Bailey "Cyclopedia of American Horticulture," Sixth Edition (1909), pp. 420-422, 894.

3. Macmillan "A Handbook of Tropical Gardening and Planting," Second Edition (1914), pp. 56-63.

4. U. S. Department of Agriculture, Farmers' Bul., Nos. 118, 157, 417.

Current Literature

Notes on Dioscoreas

(*Gardens' Bulletin*, Vol. I, No. 9, Straits Settlements.)

Additional notes have been published on Philippine yams sent to Director Burkill of the Botanic Gardens, Singapore, by Professor C. F. Baker, Chief of our Agronomy Department and by the Philippine Bureau of Agriculture. The first report on the materials appeared in the Philippine Agriculturist and Forester, Vol. III, Nos. 9-10, 1915.

One of the results of two years' observation on Dioscoreas in Singapore is the report that the caterpillars of three Lepidoptera have been found to attack this root crop. They are *Theretra nessus*, Moore, *Loxura atymnus* Horsf., and *Tagiades gana* Butl., the second of which is the most injurious. Descriptions of these insects appeared in the *Gardens' Bulletin*.

Loxura atymnus has been found only on *Dioscorea alata*, on *D. anguinna* Roxb., and on an imported African yam, and eats the young parts of the plant.

Tagiades gana feeds on the mature leaves of *D. alata* and has also been observed on *D. cirrhosa*, Lour.

Offered a choice of food-plants of the genus Dioscorea, it appeared that they refused none, but preferred *D. alata* Linn., *D. pyrifolia* Kunth, *D. bulbifera* Linn., *D. pentaphylla* Linn., and a Philippine ally of the last, thought to be *D. Cumingii* Prain and Burkill, in preference to *D. aculeata* Lamk., and *D. triphylla* Linn.

PLATE I.

SIDE VIEW.

FRONT VIEW.

BACK VIEW.

PLATE II

FRONT VIEW

SIDE VIEW

BACK VIEW

PLATE III

FRONT VIEW

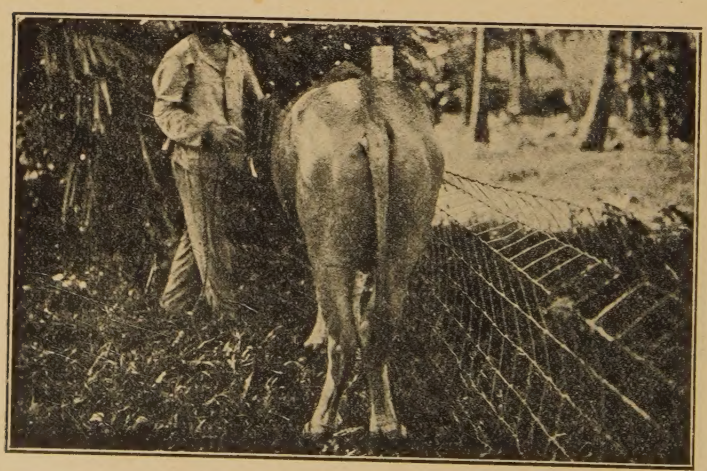
SIDE VIEW

BACK VIEW

PLATE IV

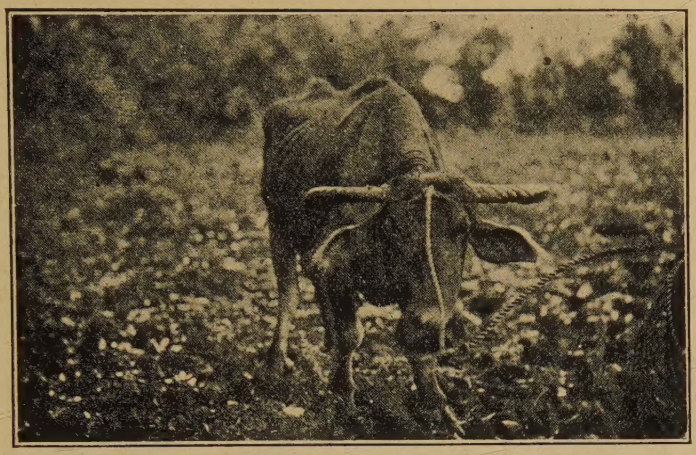
FRONT VIEW

SIDE VIEW



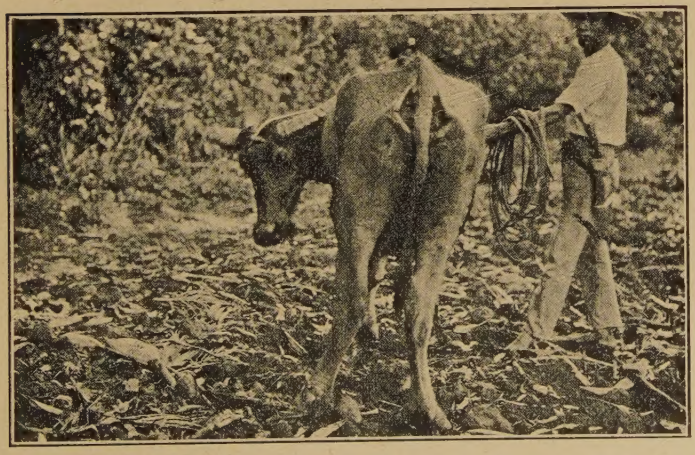
BACK VIEW

PLATE V.



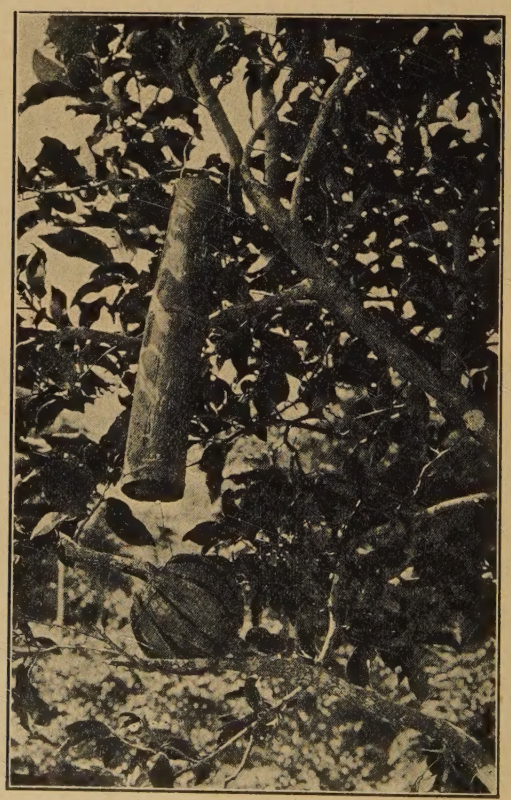
FRONT VIEW

SIDE VIEW



BACK VIEW

PROPAGATING PLOTS AND POTS



MARCOTTAGE